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Government venture capital: centralized or decentralized execution?

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Government Venture Capital:
Centralized or
Decentralized Execution?

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The researchers investigated current Government VC initiatives, interviewed subject matter experts in the VC industry, and assessed how well the Government VC initiatives are poised to fill the DoD's capability gaps as defined by the QDR. The researchers provide rationale for why VC is a relevant source for Government R&D using data from the National Venture Capital Association (NVCA) and other literature. Ultimately, the research suggests that the Government should continue to foster decentralized VC execution with increased focus on technology transference.

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GOVERNMENT VENTURE CAPITAL: CENTRALIZED OR DECENTRALIZED EXECUTION?

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I. INTRODUCTION

A. BACKGROUND

In the past decade, researchers conducted numerous studies concerning the decreased funding for research and development (R&D) within the government, including in the Department of Defense (DoD). The president decreased the FY2008 budget proposal for basic and applied research by 2.1% from the 2007 total, and in "real terms, the federal research investment would fall for the fourth year in a row after peaking in 2004" (Koizumi, 2007, para. 1). At the same time, the demand for R&D output increased. This "more with less" phenomenon forced government agencies to politic for the ever-scarcer R&D funds.

According to the American Association for the Advancement of Science's projection, "DOD support of basic and applied research would fall 18% to $5.9 billion," and "NASA research would slide 1.9% to $3.4 billion" (Koizumi, 2007, para. 6). Federal agencies operate in an environment in which R&D investment is more restrictive than 50 years ago. Faced with this challenge, many organizations are seeking new methods to leverage R&D funds and decrease delivery time to the warfighter. Some government agencies have determined to use venture capital in order to stimulate R&D despite a shrinking budget. With a public venture capital initiative, the government funds small companies or entrepreneurial organizations to foster research and development. (Lerner, 2002) Venture capital (VC) could, in fact, be the answer to the DoD's R&D problems because these initiatives promise to leverage taxpayer dollars while outsourcing risk.

Federal agencies have not agreed on the most efficient method for executing these Government VC initiatives; however, Government VC initiatives continue to be attractive, and their use is proliferating. This project deals with ten organizations with Government VC initiatives that support equity or equity-like investments in private companies. These organizations include the Small Business Innovation Research (SBIR) program, the Applied Communications Information Networking (ACIN) program, the Central Intelligence Agency's In-Q-Tel, the Army's National Technology Alliance

(NTA) partnership with the Rosettex Technology Venture Group (RTVG), the Army's OnPoint, the National Aeronautics and Space Administration's (NASA) Red Planet Capital, the Navy's Commercial Technology Transition Office (CTTO) and its Venture Capitalists at Sea (VCs @ Sea) program, and the DoD's Defense Venture Catalyst Initiative (DeVenCI). Each of these initiatives has a unique structure, vision, and purpose; thus, the Government is now challenged with making sure that funds are spent efficiently in the midst of this VC propagation. Unfortunately, "little work has been done […] to insure their greatest effectiveness" (Lerner, 2002, p. 73-74), and "a consensus as to how to structure these programs remains elusive" (p. 73).

Dr. Michael McGrath, Deputy Assistant Secretary to the Navy for Research, Development, Test and Evaluation, wrestled with this exact issue when he detailed how the Navy is evaluating implementation of VC. Should the Navy "establish a formal conduit for information sharing between the VC community and DON," "create business relationships with VC investors and portfolio companies" such as Cooperative Research and Development Agreements (CRADAs), contracts, or other transactional authority (OTA), "formalize process and funding for the rapid sourcing, screening, experimenting, testing, prototyping, and acquisition of innovative venture backed technologies," or "collaborate with Army OnPoint and CIA In-Q-Tel?" (McGrath, 2006, p. 11) At the heart of these questions is the following issue: Should the DoD manage VC in a centralized or decentralized manner?

B. OBJECTIVES

The purpose of this MBA professional report is to provide an initial qualitative and quantitative foundation of knowledge from which to determine the most efficient method of execution for Government VC initiatives in the federal government. In order to develop this foundation of knowledge, there are three objectives to this study: 1) to determine the differences, as well as the advantages and disadvantages, of the various Government VC initiatives, and 2) to compare and contrast the investment portfolios of the Government VC initiatives, and 3) to determine if the VC industry provides a relevant source for government R&D.

C. RESEARCH QUESTIONS

We will develop a synthesis of the following research questions to answer the foregoing objectives: 1) What are the characteristics of the Government VC initiatives? and 2) What are the advantages and disadvantages of the initiatives' models?

Next, we will examine the following questions to identify investment trends among the Government VC initiatives: 1) What investments have the various Government VC initiatives made (i.e., in which industries)? 2) How much have the investments been? 3) How have these investments progressed? and 4) What is the average age of the firms in which the DoD has invested, relative to the average age of firms in which private-sector venture capitalists typically invest?

Lastly, in order to determine if the VC industry can provide a relevant source for Government R&D, we will research the following issues: 1) What are the focus areas recommended by the *Quadrennial Defense Review* (*QDR*)? 2) What are the levels of investment in these *QDR* focus areas by the VC industry? 3) Are these areas feasible for a government-sponsored VC firm? and 4) What are the funding possibilities and mechanisms to support VC in these areas?

D. SCOPE OF THESIS

This research project provides an initial assessment as to whether the federal government should centrally manage VC or determine that decentralized execution by its agencies is the most effective method of execution. The researchers completed this assessment by investigating current Government VC initiatives, examining and comparing the structure and investment activities of these initiatives with the recommendations of the *QDR*. The research conducted on these programs included NASA, the Intelligence Community, and the DoD. The research focused on gaining expert opinions from department officials, VC fund managers, and individuals in the business community. It further examined the portfolio of the Government VC initiatives to determine the focus of their investments.

E. METHODOLOGY

We first conduct a literature review from professional journals, books, government reports, prior theses, and various online sources in order to understand the VC industry and Government VC initiatives. Second, we define our project's objective and research questions based on our literature review. Third, we assess three areas in detail: the VC industry, Government VC initiatives, and the *QDR*. This assessment builds the foundation for our analysis, which provides a synthesis of the three areas. Fourth, we analyze the Government VC initiatives using the information and data from the assessment. The analysis also incorporates interviews from professionals within most of the Government VC initiatives and private, independent VC firms. The analysis answers the research questions from each objective. Finally, we bring together our research questions and provide recommendations on whether a centralized Government VC initiative is preferred over a decentralized Government VC initiative.

F. ORGANIZATION OF STUDY

The organization of the study closely follows the methodology described above. Chapter II is a background on the VC industry and provides data from the 2006 *National Venture Capital Association Yearbook* (NVCA). Chapter III describes the Government VC initiatives according to timeline, background, spectrum, and data. The data is constructed similarly to the 2006 VC industry data from Chapter II. Chapter IV assesses the *QDR* and completes the information and data portion of the project. Chapter V begins our analysis and is organized according to the project objectives and their respective research questions. Chapter VI acknowledges three arguments concerning Government VC initiatives. Chapter VII is the concluding chapter; it provides a summary and recommendations based on the analysis from Chapter V.

II. VENTURE CAPITAL BACKGROUND

A. OVERVIEW OF VENTURE CAPITAL

Venture capital, in general, is funding provided to a start-up company by an individual or group of individuals to support the growth and development of the company's purpose or product. There are essentially three types of venture capital: private venture capital, corporate venture capital, and public venture capital.

The purpose of this chapter is to provide the reader with an understanding of private and corporate venture capital. The method of organization and execution for these two types of venture capital affects the federal government's use of its public venture capital initiatives. In order to determine whether the current initiatives are efficiently executing taxpayer dollars, readers must understand that there are different Models for VC. The different Models exist because organizations have differing motivations for VC. An understanding of these differences will help clarify the status quo for the VC initiatives.

1. Private Venture Capital

Private venture capital is "unique as an institutional investor asset class" because the "stock is essentially illiquid and worthless until a company matures five to eight years down the road" (NVCA, 2007a, p. 7). These investments are usually high risk, but they offer the potential for strong returns. A company that gains funding through venture capital typically raises the finances in a series of "rounds," which occur annually or bi-annually.

Venture capitalists, which are individuals who provide venture capital to the companies, can invest as an individual or via a venture capital fund. A VC fund is an investment vehicle that pools the funding of individual investors and provides the capital to companies that might be considered too risky for any one individual or bank. A VC fund diversifies the risk among a group of individual venture capitalists.

The NVCA points out, however, that VC is not simply money; VC partners "become actively engaged with a company, typically taking a board seat" (NVCA, 2007a, p. 7). The engagement of the venture capitalist supports the growth and development of the company by utilizing the expertise of that person.

2. Corporate Venture Capital

Corporate VC is an equity investment in entrepreneurial ventures made by established companies such as Intel, Microsoft, and Merck. The corporation provides direct funding to an external, start-up company (Chesbrough, 2002). In general, corporate VC aims to achieve one of two goals: 1) strategic investments to increase the corporation's own sales and profits by identifying advantages between the corporation and the new venture (2002), or 2) financial investments the corporations believes will earn strong returns based on the corporation's knowledge of a particular industry (2002).

Entrepreneurial ventures are most often new, privately owned, start-up firms that are seeking capital to continue operations (Gompers & Lerner, 1998). The ability to integrate external knowledge with internal skills is essential to an organization's dynamic capability (Dushnitsky & Lenox, 2005; Henderson & Cockburn, 1994; Teece, Pisano, & Shuen, 1997). Drucker (1974) argued,

> The search for innovation needs to be organizationally separate and outside of the ongoing managerial business. Innovative organizations realize that one cannot simultaneously create the new and take care of what one already has. They realize that maintenance of the present business is far too big a task for the people in it to have much time for creating the new, the different business for tomorrow. They also realize that taking care of tomorrow is far too big and difficult a task to be diluted with concern for today. Both tasks have to be done. But they are different. Innovative organizations, therefore, put the new into separate organizational components concerned with the creation of the new. (p. 799)

Tushman and O'Reilly (2002) share Drucker's view about separating different innovative organizations; they refer to it as "managing innovation streams in ambidextrous organizations" (p. 167). An ambidextrous organization "operates in multiple modes simultaneously; managing for short-term efficiency by emphasizing

stability and control, as well as for long-term innovation by taking risks and learning by doing" (Tushman & O'Reilly, 2002, p. 167).

Corporate VC success has been cyclical—with firms entering and leaving with few long-term commitments (Chesbrough, 2000; Rind, 1980). Based on past performance, it appears that private venture capitalists feel large companies lack the flexibility and managerial skills necessary to operate a corporate VC organization (Chesbrough, 2000). Strategy plays a vital role for the survival of a corporate VC organization (Chesbrough, 2002; Dushnitsky & Lenox, 2005; Gompers & Lerner, 1998).

Gompers and Lerner (1998) found that corporate VC programs without a strong strategic focus are unstable and have a shorter lifespan than those with a stronger strategic focus. Additional published sources agree with Gompers and Lerner (1998) that strategy is more important than financial returns for corporate VC programs (Chesbrough, 2002; Dushnitsky & Lenox, 2005). Strategy incorporates external and internal capabilities.

Corporate VC programs that seek external knowledge to leverage internal capabilities have greater innovation rates (Dushnitsky & Lenox, 2005). Larger companies can leverage complementarities, with corporate assets ranging from technology to intangible assets such as knowledge-based assets, brand, or the companies' reputation (Chesbrough, 2000). Gompers and Lerner (1998) also found that "potential complementarities with existing lines-of-business suggest that corporate investments may also perform well, at least those where there is a strong strategic fit" (p. 25).

If corporate VC wants to deliver strategic benefits to its sponsoring companies, then it cannot merely mirror private VC. A hybrid between private VC and pure corporate VC provides balance to deliver strategic benefits (Chesbrough, 2000). Pure corporate VC, or a new ventures division, operates internally—with management from inside the company. In this type of corporate VC, management is not given entrepreneurial awards (Rind, 1980). Chesbrough (2002) and Rind (1980) agreed on a hybrid structure that maximizes the strategic benefits of private VC and leverages the potential advantages of corporate VC.

3. Public Venture Capital

Public venture capital programs "make equity or equity-like investments in young firms, or encourage other intermediaries to make such investments" (Lerner, 2002, p. 73). Historically, the federal government's efforts to support public venture capital programs are based on at least one of two assumptions: 1) new firms do not receive enough funding from the public sector, or 2) the government can invest in technologies to provide high social benefits, which might also encourage private investors to provide funding as well. (Lerner, 2002)

From these definitions, the reader can see that the goal of public venture capital differs from private and corporate venture capital. Instead of seeking financial returns, public venture capital aims for "social benefits." What are these social benefits? Lerner suggests that new firms that operate on the edge of technology might not receive enough funding from investors because of the high risks involved. In this instance, the government may reassure investors in what is called a "certification effect"; this could help investors overcome their concerns to confidently invest in these firms (Lerner, 2002). From this perspective, the social benefit of public venture capital programs is the development of a project for the federal government's use that might otherwise have never been developed.

The second social benefit is the idea of R&D spillovers. Lerner explains that investments in activities that generate positive externalities, such as R&D and pollution control, may not provide financial returns, but have positive spillovers that help other firms or society as a whole. Because the financial return may not justify the execution of the project, the government should consider the benefits of getting involved (Lerner, 2002).

Both of these arguments lead directly to the venture capital initiatives discussed in this report. The ever-decreasing R&D budget has made necessary a method for accessing and supporting product development for the federal agencies. The structure, objectives, and methods for these specific initiatives are discussed in the following chapter.

B. VENTURE CAPITAL INDUSTRY 2006

According to the 2007 *National Venture Capital Association* (NVCA) *Yearbook*, the United States' VC industry maintained its consistent growth in 2006. The areas analyzed in the VC industry are: industry resources, investments, portfolio company valuations, exits (Initial Public Offerings and Acquisitions), and performance (NVCA, 2007a). The data, figures, and tables presented in this section are from the *NVCA Yearbook* (2007a), published by Thomson Financial.

A Government VC has different objectives, which must complement its strategic objective within the VC industry. The Government VC does not necessarily need to mirror the VC industry's performance. However, the Government VC needs to understand the VC industry and what it has to offer. The following data is presented on the different areas of the VC industry for 2006 and provides insight into some of the questions raised in the introduction.

1. VC Industry Resources

Venture capital under management, the total dollar amount available for VC investments, was $235.8 billion for 2006, a decrease of $29.6 billion from 2005. However since 1998, total capital under management has increased 161%. The total capital under management is broken down by firm type in the following figure:

	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Private Independent	39015	49867	73491	117891	183411	207142	208333	208497	214724	220847	197827
Financial Institutions	5960	8485	11590	17949	26641	28784	27974	27051	26806	24912	20687
Corporations	3096	3339	4150	8596	15397	17165	17182	16920	16303	17112	15073
Other	729	1109	1268	1564	2351	2708	2710	2731	2867	2529	2214
Total	48800	62800	90500	146000	227800	255800	256200	255200	260700	265400	235800

Figure 1. Total Capital under Management by Firm Type, 1980 to 2006 ($ Millions) [From NVCA, 2007]

Private independent firms managed the largest amount of capital with 84% of the total, followed by financial institutions with 9%, corporations with 6%, and others with 1%. The top five states with the most capital under management were California,

Massachusetts, New York, Connecticut, and Maryland. These five states managed 80% of the total capital under management, with California continuing its dominance with $93.2 billion. (NVCA, 2007a) The following figure shows the total capital managed by the top five states:

State	($ Millions)
CA	93,206.20
MA	39,774.70
NY	31,063.70
CT	14,290.20
MD	9,729.70
Total*	**188,064.50**

** Total includes above 5 states only*

Figure 2. Top 5 States by Capital under Management, 2006 [From NVCA, 2007]

At the end of 2006, approximately 43% of all venture capital firms managed up to $50 million, while 21% managed at least $250 million. 96 firms managed at least $500 million, while 98 firms managed up to only $10 million. The following figure breaks down the distribution of firms by capital managed and the budget for each firm (i.e. 98 firms managed or had $0-$10 million for investments):

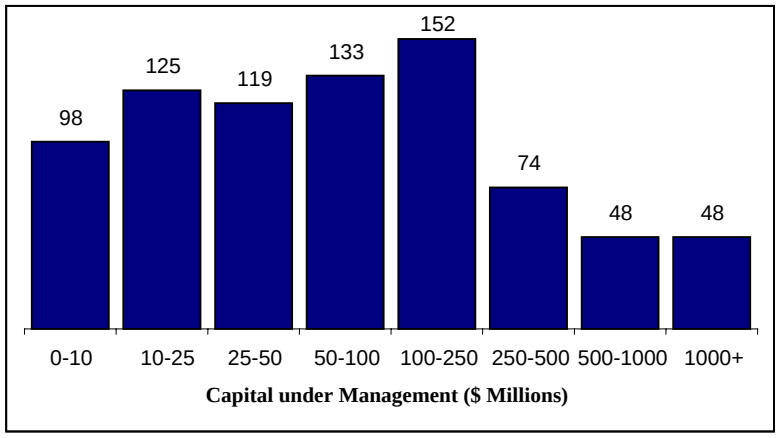

Figure 3. Distribution of Firms by Capital Managed, 2006 [From NVCA, 2007]

Venture capital continued its trend of concentrating greater amounts of capital in fewer hands, with the number of existing firms dropping from 872 to 798. On average, each firm was responsible for financing about four companies in 2006, contrasted to three companies in 2005. While the average fund size increased by $8 million from 2005 to 2006, the average firm size decreased by $8.9 million. Recent data of closed funds show that most venture funds significantly exceed the designated life of 10 years (NVCA, 2007a).

2. VC Industry Investments

The amount of VC invested in 2006 increased to $25.9 billion—a 14% increase from 2005. The computer software sector led with 19% of the financing, followed by biotechnology and then communications (NVCA, 2007a). The following figures show the investments by industry group and sector:

	All Investments		Initial Investments	
Industry Group	**No. of Companies**	**Investment Amt $Bil**	**No. of Companies**	**Investment Amt $Bil**
Information Technology	1,858	14.9	672	3.5
Medical/Health/Life Science	669	7.7	293	1.7
Non-high Technology	383	3.4	150	0.7
Total	**2,910**	**25.9**	**1,115**	**5.9**

Figure 4. 2006 Investments by Industry Class [From NVCA, 2007]

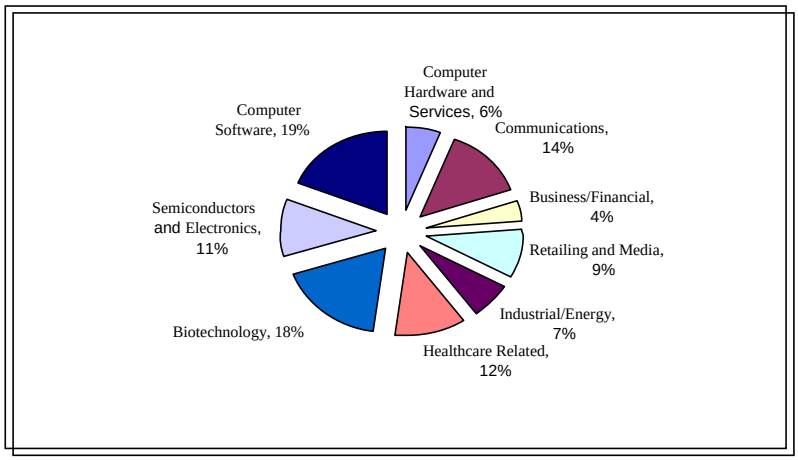

Figure 5. Venture Capital Investments in 2006 by Industry Sector [From NVCA, 2007]

The leading recipient of venture capital investment was California, with $12.5 billion (or 48% of the total invested). That 48% was the highest percentage since 1983 and represented investments in 1,224 portfolio companies. Massachusetts ($2.8 billion), Texas ($1.4 billion), New York ($1.3 billion), and Washington ($1 billion) were the other leading recipients. The District of Columbia had the highest percentage gain for states with 256%—receiving at least $100 million (NVCA, 2007a).

Startup and seed stage companies received $1.1 billion in investments, a 44.2% increase from 2005. This high percentage is explained by the industry finishing up existing projects and focusing on new, upcoming deals. Financing increased in all stages except the later stage, but the later stage still brought in 36% of all financing. The expansion stage received the most: $11.5 billion (NVCA, 2007a).

Initial-round and follow-on financing both increased; each was the highest since 2001. On average, a company received $5.26 million in initial-round financing and $10.25 million in follow-on financing. The total number of companies receiving financing was 2,910 in 2006 (NVCA, 2007a). Figure 6 shows the venture capital investments by stage. Figures 7 and 8 show investments by first versus follow-on rounds by total dollars invested and total number of companies:

Stage	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Startup-Seed	1297	1287	1316	1769	3254	3119	722	297	338	412	795	1146
Early	1770	2849	3580	5549	11910	25672	8708	3904	3546	4032	3689	3951
Expansion	3794	5461	7728	10544	30182	59867	23088	12383	10047	9261	8678	11479
Later	1266	1682	2279	3227	8860	16325	8179	5246	5754	8433	9617	9347
Total	8126	11279	14903	21088	54206	104983	40696	21830	19685	22138	22778	25922

Figure 6. Venture Capital Investments 1995 to 2006 by Stage ($ Millions)
[From NVCA, 2007]

Year	First	Follow-on	Total
1995	4151.7	3974.7	8126.5
1996	4325.0	6953.5	11278.6
1997	4898.5	10004.5	14903.0
1998	7172.3	13916.1	21088.4
1999	16044.9	38160.8	54205.7
2000	28945.1	76038.2	104983.3
2001	7445.8	33250.4	40696.3
2002	4372.3	17457.7	21829.9
2003	3948.0	15737.0	19684.9
2004	4752.4	17385.3	22137.7
2005	5603.1	17175.7	22778.8
2006	5869.0	20053.1	25922.2

Figure 7. Venture Capital Investments, First vs. Follow-on Rounds ($ Millions) [From NVCA, 2007]

Year	# of Co.s Receiving Initial Round Financing	# of Co.s Receiving Follow-on Financing	# of Co.s Receiving Financing*
1995	893	754	1545
1996	1144	1134	2078
1997	1289	1446	2536
1998	1411	1794	2973
1999	2443	2398	4410
2000	3368	3633	6340
2001	1219	2733	3787
2002	838	1890	2619
2003	746	1767	2416
2004	903	1774	2574
2005	995	1768	2646
2006	1115	1957	2910

**NVCA doesn't explain why the total doesn't add up correctly*

Figure 8. Venture Capital Investments, First vs. Follow-on Rounds (Total # of Co.s) [From NVCA, 2007]

3. Portfolio Company Valuations

The improvement in the public markets helped increase the average venture round valuations in 2006. For companies receiving financing between 1995 and 2006, communication companies had the highest average valuation at $78 million, followed by the computer hardware and services sector with $75.1 million. The average value for additional rounds ($80.7 million) following first-round financing was higher than first

rounds ($14.9 million) in 2006. The average post-initial public offering (IPO) valuation was more than two times the average pre-IPO valuation. The post-offering valuation increased from 2005 to 2006, with an average valuation of $390.2 million for IPOs. However, this increase was still far below record levels and emphasized the need for venture capitalists to efficiently distribute capital to portfolio companies (NVCA, 2007a).

4. Exits (IPOs and Acquisitions)

Venture-backed IPOs increased to 57 in 2006 from 56 the previous year and accounted for just 34% of all U.S.-based IPOs. However, these IPOs had a 35% return in 2006, contrasted to 13.5% for the S&P 500 and 8.2% for NASDAQ. The biotechnology industry had the highest venture-backed IPOs (with 17) and the highest offering (with $855 million). The median age of all venture-backed IPOs increased to 96 months in 2006 from 72 months the previous year. On average, only one in six companies ever goes public (NVCA, 2007a). The following figure shows the data on venture-backed IPOs:

Year	Num of IPOs	Offer Amount ($ mil)	Med Offer Amt ($ mil)	Mean Offer Amt ($ mil)	Post Offer Value ($ mil)	Med Post Value ($ mil)	Mean Post Value ($ mil)	Med Age @ IPO (yrs)	Mean Age @ IPO (yrs)
1995	204	8117	33	41	31073	110	155	7	9
1996	273	11539	32	42	56538	110	207	6	8
1997	137	4820	30	35	22126	108	160	6	8
1998	78	3782	41	48	17253	182	221	5	7
1999	266	20395	63	77	134000	342	496	4	6
2000	263	25419	73	97	133119	247	504	5	7
2001	40	3419	71	85	18004	322	439	6	11
2002	22	2109	71	96	7950	223	361	7	11
2003	29	2023	66	70	8257	228	285	8	9
2004	93	11015	69	118	61091	255	657	7	8
2005	56	4461	66	80	16464	203	294	6	8
2006	57	5117	76	90	22242	255	390	8	10

Figure 9. Venture-backed IPOs, 1995 to 2006, Value and Age Characteristics [From NVCA, 2007]

According to the *NVCA Yearbook* (2007a), the most feasible route to exit for venture-backed companies was through a merger and acquisition (M&A). Venture-

backed M&A activity decreased slightly to 336, but accounted for 85% of the total exits in 2006. The software industry had the highest number of exits (with 125), which was more than four times the next leading sector. The average purchase price for the M&A exits for 2006 was $109.8 million (NVCA, 2007a).

5. VC Industry Performance

Venture funds had a one-year, 7% internal rate of return (IRR) for 2006. The five-year average is the only one with a negative IRR due to the decline in the early 2000s, but all other time horizons had a positive IRR. Early-stage-focused funds had the lowest IRR, which was different from historical pattern. Early-stage funds usually outperformed other funds, which pattern was consistent with financial theory of risk and return. However, in recent years, the early-stage funds were valued flatly until it received additional funds in latter stages of financing (NVCA, 2007a). The following figure displays the IRR for all venture and private equity investments for different time horizons and fund type:

Fund Type	1YR	3YR	5YR	10YR	20YR
Seed/Early Focused	2.6	5.5	-5.4	38.3	20.5
Balanced Focused	7.5	12.9	1.9	16.9	14.6
Later Stage Focused	14.5	8.9	1.8	9.0	13.7
All Venture	7.0	9.1	-1.2	20.5	16.5
Buyout Funds	21.6	15.6	9.1	8.8	13.2
Mezzanine Debt	-0.4	4.8	2.9	5.9	8.4
All Private Equity	16.5	13.1	5.8	11.2	14.0

Figure 10. Net IRR for Investment Horizon Ending 09/30/2006 for Private Equity Funds [From NVCA, 2007]

Venture investors received $9.8 billion in the nine months in 2006, in contrast to $20.2 billion from 2005. This was due to the poor IPO markets and depressed acquisition markets. According to the *NVCA Yearbook* (2007a), "When there is too much money chasing too few good deals, those good deals tend to be bid up in price early on, making it difficult for venture capital general partners to reward their investors with suitable

returns" (p. 15). One way to forecast the expected future liquidity is to compare the annual VC investments to the amount of new capital in the public markets. In 2006, VC investment was $26 billion, compared to $158 billion in the public market. This six-to-one ratio is probably short of what is needed and a signal that the amount of investment by the VC industry is too high (NVCA, 2007a).

Assessment of the VC industry provides the researchers a framework with which to assess and analyze the various Government VC initiatives. The next section is an assessment of some current Government VC initiatives. Some of the same areas from the VC industry will be incorporated in this discussion. The goal of assessing the Government VC initiatives is not to make a direct comparison to the VC industry, but instead to see how the government can get involved in the VC industry.

III. VENTURE CAPITAL INITIATIVES

A. TIMELINE OF GOVERNMENT VC INITIATIVES

In this section, the researchers discuss nine Government VC initiatives: the SBIR program, In-Q-Tel, the CTTO, the ACIN program, the NTA RTVG, the VCs @ Sea program, OnPoint, Red Planet Capital, and DeVenCI. The figure below details the progressive establishment of Government VC initiatives.

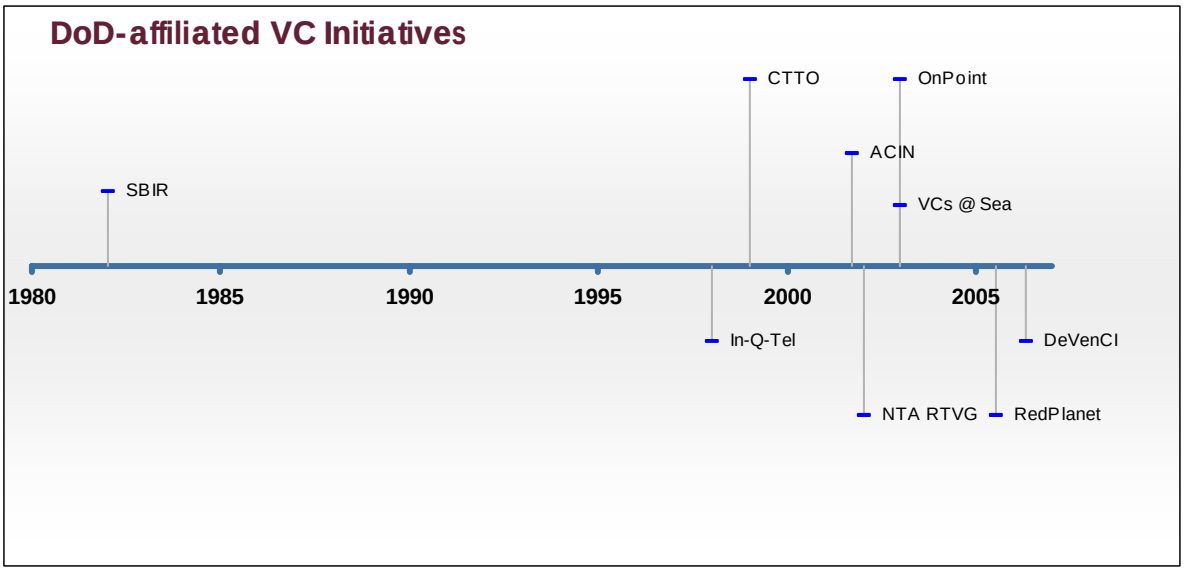

Figure 11. Timeline of Government VC initiatives

B. BACKGROUND OF GOVERNMENT VC INITIATIVES

This section provides background information on the structure, objectives, and methods for the Government VC initiatives that are the focus of this report.

1. Small Business Innovation Research (SBIR) Program

In 1982, Congress passed the *Small Business Innovation Development Act*, which created the SBIR program and "emphasized the benefits of technological innovation and the ability of small businesses to transform the results of R&D into new products" (GAO, 1999, p. 14). In the Act, Congress established four primary goals for the SBIR program:

1. Stimulate technological innovation.

2. Use small businesses to meet federal R&D needs.

3. Foster and encourage participation by minorities and disadvantaged persons in technological innovation.

4. Increase the private sector's commercialization of innovations derived from federal R&D.

The policy directives of the SBIR program are developed and managed by the Small Business Administration (SBA). These directives state:

> [That] to be eligible for an award, a small business must meet the following characteristics: independently owned and operated, other than the dominant firm in the field in which it is proposing a SBIR project, organized and operated for profit, an employer of 500 or fewer employees, the primary source of employment for the project's principal investigator at the time of the award and during the period when the research is conducted, and at least 51% owned by U.S. citizens or lawfully admitted permanent resident aliens. (GAO, 1999, p. 14)

There are three phases of the SBIR program. Phase I cannot exceed six months, and grants within that timeframe cannot surpass $50,000 to the awardee. Phase I "was designed to determine the scientific and technical merit and the feasibility of a proposed idea" (p. 14). In its 1982 specifications, Phase II could not exceed two years, surpass $500,000 granted to the awardee and was designed to improve the technology developed in Phase I. Then in 1992, Congress directed the SBA to raise the grant amounts to $100,000 for Phase I and $750,000 for Phase II efforts. In contrast to the first two phases, Phase III "has no general limits in time or dollar amounts," and "a Phase III project must obtain funds from non-SBIR sources in the federal government or in the private sector" (p. 14) to include VC firms.

2. In-Q-Tel

In 1998, the Central Intelligence Agency (CIA) explored the validity of VC to enhance R&D procurement. The CIA realized the fundamental differences between VC and public R&D investment. Specifically, the CIA recognized the belief that

governments, especially in the United States, normally do not get involved with equity investment and ownership of companies. However, despite this difference, leadership in the CIA realized that:

> The Agency was struggling to keep pace with change in this new digital age, where information was abundant and the communication medium was high technology. The Agency was experiencing an "IT gap" caused by the speed of change and innovation in the commercial high technology sector […the] CIA recognized that it needed to develop IT quickly. To do this, the leadership acknowledged that the Agency needed to tap into the private sector IT world's high energy. (Business Executives for National Security [BENS], 2001, p. 1)

This recognition resulted in the establishment of In-Q-Tel, a non-profit, government-chartered corporation with the stated goal: "to exploit and develop new and emerging information technologies and pursue R&D that produces innovative solutions to the most difficult problems facing the CIA and Intelligence Community" (BENS, 2001, p. 6).

Norman Augustine, former CEO of Lockheed Martin, founded In-Q-Tel at the request of the CIA in response to George Tenet's "Strategic Direction" initiative:

> Beginning with the critical field of IT, we will pursue this [new] approach through the creation of an external nonprofit enterprise designed to be electronically connected to leading research throughout the country. This new entity will speed insertion of mature technologies, support rapid development of mission-critical applications, and enhance our ability to attract the skills and expertise vital to our success. (BENS, 2001, p. 5)

In-Q-Tel was formed to be an agile and flexible entity that could work independently with firms in Silicon Valley and throughout the world. In-Q-Tel was a mix of corporate strategic VC, business, nonprofit and Government R&D Models (Lerner, Hardymon, Book, & Leamon, 2004). The In-Q-Tel Model was not a substitute for traditional Government R&D funding, but rather leveraged government and private-sector investments in research (Cotell, 2006).

In-Q-Tel was initially a technology systems integrator that searched for commercial off-the-shelf technologies to meet the CIA's needs (BENS, 2001). In-Q-Tel

has evolved from a systems integrator into a catalyst to developing technologies that are commercially viable and serve the specific needs of the intelligence community. In-Q-Tel can serve as a partner with the public, with private companies, and with academic institutions and laboratories (Molzahn, 2003).

In-Q-Tel is comprised of four discrete entities: the CIA, In-Q-Tel Interface Center (QIC), In-Q-Tel, and commercial firms/academia. The QIC is an organization within the CIA that works exclusively with In-Q-Tel by ensuring that the CIA's requirements are accurately identified before they are passed to In-Q-Tel; the QIC is also responsible for the transition of commercial IT solutions from In-Q-Tel to the Agency. The QIC and In-Q-Tel use a collaborative process, the "Q Process," for the development and execution of projects (Molzahn, 2003). The QIC provides In-Q-Tel with a "Problem Set" that outlines the investments in which the firm would operate (Lerner et al., 2004).

The first "Problem Set" defined by QIC in 1999 had four investment areas: information security, internet, knowledge generation, and distributed architectures. The investment areas were subdivided and further refined before QIC distributed the "Problem Set" to In-Q-Tel. The "Problem Set" evolved to include five areas: Geo-spatial technology, distributed data collection, security and privacy, knowledge management, and search and discovery. The "Problem Set" does not change in response to current events, but rather is designed to provide In-Q-Tel with a clear investment framework (Lerner et al., 2004).

Dr. Catherine Cotell, In-Q-Tel's Vice President in 2006, asserted before the Science Committee of the House of Representatives that, "Before In-Q-Tel makes an investment, members of three teams conduct diligence to ensure that the investment is on firm footing" (Cotell, 2006, The In-Q-Tel Approach, ¶2). The first team is composed of members of QIC, as previously mentioned. The second team consists of In-Q-Tel's staff of technology experts who try to match new emerging technologies with the needs of the intelligence community. The third team is In-Q-Tel's venture team members, who are responsible for researching the market and reviewing the company's business plan and management team (Cotell, 2006).

The CIA charters and provides funding for In-Q-Tel from the federal intelligence budget appropriations (Lerner et al., 2004). However, In-Q-Tel is an independent entity and does not need approval from the CIA for its business deals (Molzahn, 2003). In-Q-Tel was chartered to invest in commercially viable businesses for many reasons. The CIA wanted to keep the companies that produced software and technology for the CIA in business. Technologies targeted for the commercial sector were more flexible, able to change and cost-effective compared to one-off customized products. In-Q-Tel also hoped for some financial returns, even though its first priority was return on technology for the intelligence community (Lerner et al., 2004).

3. National Technology Alliance (NTA) Rosettex Technology Venture Group (RTVG)

The NTA RTVG was established in 2002, and is "a U.S. Government program with an objective of influencing commercial and dual use technology development in support of national security and defense requirements" (Deitch, 2004, p. 25). The organization aims "to reduce development and sustainment costs across the life cycle" (Deitch, 2004, p. 25). In 2002, the NTA partnered with Rosettex Technology and Venture Group (RTVG), using Other Transaction Authority (OTA), to establish a cooperative joint venture to enable the government to obtain "access to best of class solutions from a team of over 70 information technology organizations representing universities, non-traditional contractors and traditional system integrators" (Deitch, 2004, p. 25).

The OTA arrangement supported relaxed "language regarding Intellectual Property" to enhance the program's attractiveness to industry (Deitch, 2004, p. 25). The NTA's chief technology officers are concerned with three primary technology areas: Geo-spatial intelligence, information-processing analysis and management, and digital technology infrastructure. Deitch (2004) listed Rosettex's current programs as:

- Video motion-mining techniques, archiving, retrieval, and exploitation capabilities development for Defense and Homeland Security applications

- Development of integrated navigation and accurate geo-positioning from video imagery to enhance position location
- Pre-commercialization prototyping of a neural network image processing, pattern recognition and learning model
- Prototyping of eye-imagery registration, fusion and analysis tools to create 3-D retinal maps for early eye disease diagnosis
- Adapting the discovered capabilities of super fusion and super resolution to DoD and IC use (bullets in original, p. 25)

Rosettex Venture Fund is independent of RTVG, but receives funds from the profits generated from NTA contracts (Caterinicchia, 2002). The NTA has no direct equity ownership under this structure, but this fund invests in companies with technologies that have dual-use potential for the military and the commercial sector (Deitch, 2004). Gilman Louie, the first president and CEO of In-Q-Tel, was one of the advisors to the fund (Caterinicchia, 2002).

4. Navy's Commercial Technology Transition Officer (CTTO)

In 1999, the Assistant Secretary of the Navy (Research, Development, and Acquisition) created the CTTO position with the objectives to: provide objective, independent, system-oriented technology assessments, promote the rapid insertion of technology from any source, advise on matching the Navy's business and technology insertion strategies, evaluate potentially disruptive technologies and alert leadership to their prospects, and to develop policies and tools to improve Navy utilization of technology (Office of Naval Research, 2007). In seven years, the CTTO has provided funding for 55 technology transition deals.

The Office of Naval Research is responsible for the CTTO. In concert with the CTTO, the ONR supports the Naval Research Advisory Committee (NRAC) Venture Capital Technology Panel. This panel works with the CTTO to develop a technology roadmap that identifies technologies to incorporate into the Navy (Office of Naval Research, 2007). In general, the CTTO works to identify the Navy's operational needs and match them with potential solutions in the commercial industry. There are two

elements to this activity: "spin-out" and "spin-in" technologies. Spin-out activities are Navy intellectual property licensed to the commercial sector, while spin-in activities provide commercial technologies to the Navy. The hope with spin-in activities is that the service will become more aware of emerging technologies that have the potential to support the Navy's current and future operational needs (Lawlor, 2003).

5. Venture Capitalists @ Sea (VC @ Sea) Program

In 2003, the CTTO embarked upon the VCs @ Sea program to get venture capitalists involved in spin-out and spin-in technologies. In contrast to In-Q-Tel, the CTTO wanted to explore the possibility of introducing new technologies into the Navy without having to request funds from Congress (Lawlor, 2003). This approach resulted in six deals with companies that possessed promising technologies.

The VCs @ Sea program supported this relationship by fostering trust between the venture capitalists and the government. The CTTO engaged with some of the top-tier VCs in the country and provided them the opportunity to interface with the Navy and Marines including trips aboard ships to see first-hand how the technologies would be used. This feedback provided the VCs with a better understanding of the requirements (Lawlor, 2003). Despite this relative success, the CTTO no longer executes the VCs @ Sea program due to budget constraints.

6. Applied Communication and Information Networking (ACIN)

In the fall of 2001, the U.S. Army's Communications—Electronics Command (CECOM), in conjunction with Drexel University and Sarnoff, opened ACIN in Camden, New Jersey (Deitch, 2004). The building complex is a "state-of-the-art 'wired' modular office environment and shared information technology laboratory space," which fosters "collaboration, creativity, and flexibility, in order to facilitate the commercialization of technology" (Deitch, 2004, p. 17). The ACIN environment is meant to provide a "'grow-as-you-go' space [to support] the development of companies as they expand from one to 25 workers" (Deitch, 2004, p. 17-18). As an incentive to industry, data rights for commercial purposes were retained, thereby facilitating the flexibility to spin technology

into the small-business sector. Designed to return investment back into the program, 5% of royalties paid resulting from work performed under the ACIN program is to be utilized for maintenance and operations of the ACIN Center of Excellence (Deitch, 2004).

The goals and objectives of ACIN are: Education and training, rapid technology exploitation, technology assessment and evaluations, leveraging commercial industry to better address government needs, commercialization, and user support. ACIN focuses on innovation through these goals and objectives. In order to facilitate commercialization, ACIN partners "with industry, universities and venture capital firms to bring technology to market, to include licensing intellectual property, and incubating new companies" (Deitch, 2004, p. 18).

ACIN is unique because it is the first incubator devoted to defense technologies. The arrangement provides tangible benefits for both industry as well as the government by providing companies with office space and by allowing the government to get a first look at emerging technologies. This open "architecture" helps the military increase its innovative practices by gaining insights into organizations and technologies that would not normally be doing business with the government (Deitch, 2004).

7. OnPoint

Encouraged by the success of In-Q-Tel, Congress included $25 million in the FY2002 DoD Appropriations Bill for the Army to utilize VC. According to Jason Rottenberg (2006), the current director of OnPoint, the purpose of the appropriations bill is:

> to fund a venture capital investment corporation (VCI) with the expectation that such a vehicle would provide the Army with greater visibility into the technical development activities of technology development companies and would accelerate the transition of new or significantly improved technologies into the Army more quickly and efficiently. (p. 1)

Initially, the Army hired MILCOM Technologies (a small equity firm with experience in the defense and commercial sectors) to manage VCI activities. However,

in 2003, the Army worked with MILCOM to establish OnPoint Technologies as the Army's VC initiative (Rottenberg, 2006).

OnPoint is specifically interested in companies that do not normally do business with the government. OnPoint helps these companies transfer technologies to better equip soldiers and/or reduce the costs associated with such equipment. OnPoint focuses primarily on power technologies, such as portable fuel cells, improved rechargeable batteries, and numerous power-generation technologies (Rottenberg, 2006).

8. NASA's Red Planet Capital

NASA initiated the VC project Red Planet Capital in 2006. Congress approved the program for Red Planet Capital, but the White House disapproved. Red Planet Capital is now a private venture capital firm with investors from the major aerospace companies. Red Planet Capital is now called Astro-Lab Ventures and still plans to work with NASA, but under a different construct than did Red Planet Capital (Burnette, 2007). Red Planet Capital originally planned to address three key challenges:

1. Attract and motivate private-sector innovators and investors who have not typically conducted business with NASA, including tapping more efficiently into the pool of small, leading-edge organizations which are responsible for much of the innovative high-tech thinking and research in the U.S.,

2. Leverage existing external capital to encourage development of technologies and products likely to be of future use to NASA's mission, and

3. Improve and expedite public/private partnership formation through redesign of administrative, management, and legal processes and procedures.

Red Planet Capital was designed as an investment vehicle to support innovative, dual-use technologies for NASA's mission and commercial use.

NASA adopted the In-Q-Tel Model to design Red Planet Capital. In-Q-Tel's former president, Michael Griffin, the administrator of NASA, was a key player in the project (Kaufman, 2006). Red Planet Capital planned to invest in new, promising

technologies via equity financing instruments and by leveraging existing private-sector, corporate, and financial venture funds.

9. Defense Venture Catalyst Initiative (DeVenCI)

Recently, the DoD established DeVenCI in order to identify the potential benefits of VC. In contrast to initialization of earlier Government VC initiatives, DeVenCI and the Pentagon are subtly approaching the potential use of VC by providing "a forum for Department of Defense officials and venture capitalists to meet to prioritize the military's needs, which are then communicated to technology companies" (Carlson, 2006, ¶ 7). DeVenCI's website says it aims to accomplish this broad goal using workshops, technical expositions, industry outreach, and its web portal. These mediums will increase the visibility of DoD needs to commercial companies and technology area experts—hence earning the term "catalyst" in its name (DeVenCI, 2007).

We emphasize that DeVenCI is a *catalyst*; it does not make investments in companies. DeVenCI does not leverage positions in commercial companies, nor does it aid in technology transfer. This approach requires specific DoD users to be responsible for any long-term development and procurement of promising technologies (DeVenCI, 2007).

C. SPECTRUM OF GOVERNMENT VC INITIATIVES

The preceding section provided a general overview of Government VC initiatives. The organizational structures, operational methods, and end-goals vary considerably among these programs. This paper's thesis of whether the government should centralize or decentralize VC execution centers on the core differences of the initiatives. Are these differences good or bad? Do the differences support or hurt the government's efforts to enhance R&D? We attempt to gain the insight necessary to answer these questions by introducing a spectrum for the Government VC initiatives.

Why is a spectrum important? By defining a spectrum of the Government VC initiatives, the researchers can gain a better understanding for why the initiatives are different and an understanding of how they achieve their goals. At the same time, we can

compare and contrast the initiatives to determine the relative effectiveness of each initiative's approach. Ultimately, the spectrum will help us with our determination of whether to centralize or decentralize VC execution.

The concept for categorizing government efforts along a spectrum is not new. In fact, in July 2004, the National Defense University's (NDU) Center for Technology and National Security Policy (CTNSP) presented a briefing entitled "Actions to Enhance the Injection of Commercial IT in DoD Systems: A Synthesis Perspective." In this meeting, the CTNSP recognized the very same problems that the entire DoD struggles with concerning IT: 1) IT is critical to the transformation of the DoD; 2) the cost of IT is challenging, and 3) innovation in IT is primarily occurring in the commercial sector (CTNSP, 2004, p. 9). All of these problems were increasingly challenging because the commercial sector viewed the DoD as "non-attractive, non-transparent, and very isolated" (CTNSP, 2004, p. 10).

As the CTNSP struggled with identifying improved methods for accessing innovative technologies, it surveyed existing methods and developed a spectrum with which categorize the methods' actions. The CTNSP analysis of the DoD's engagement strategy in 2004 evaluated efforts like SBIR, Army VC, In-Q-Tel, DARPA, and the Navy's CTTO and categorized them along two axes: activity type and company maturity. The resulting "spectrum" is shown in Figure 12 below (CTNSP, 2004, p. 11).

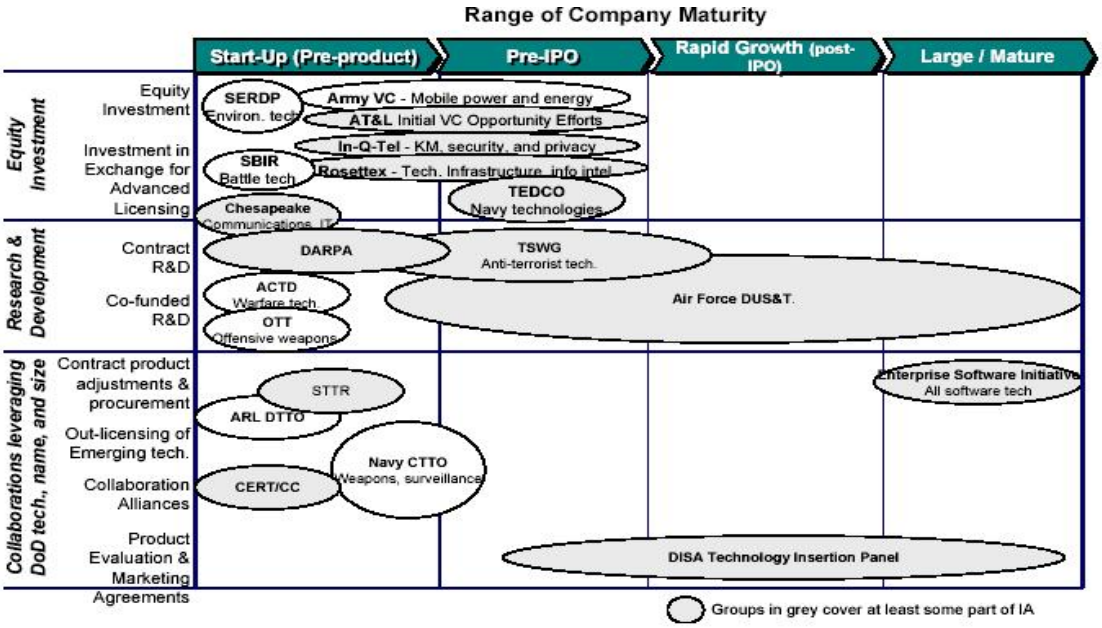

Figure 12. DoD's Current Engagement Strategy (2004) [From CTNSP, 2004]

For this paper, we have categorized the existing Government VC initiatives along a spectrum according to the method the VC initiative uses to facilitate the exchange of information between the commercial sector and the government. What are the different methods for facilitating this exchange?

The primary distinction between the Government VC initiatives in this paper is how funds are used to facilitate the exchange of information between the commercial sector and the government. There are three Models on the spectrum: the Equity Investment Model, the Grants Model, and the Communication Catalyst Model. Figure 13 shows how the Government VC initiatives are arrayed along this spectrum.

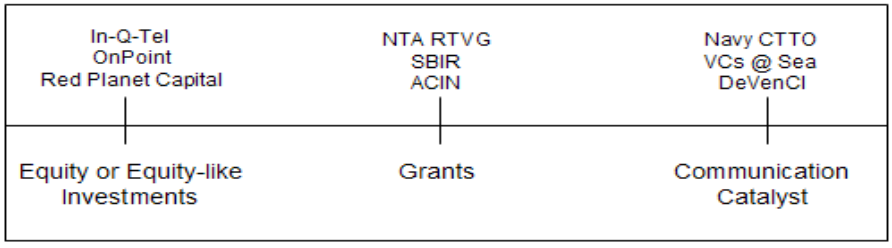

Figure 13. Government VC Initiative Spectrum

1. Equity Investment Model

For the Equity Investment Model, the government provides funding to an external organization to purchase equity in a company. For the initiatives covered in this paper, the external organizations are independent, non-profit entities. Why are they purchasing equity? The Government VC initiatives use equity ownership to leverage control within the company. Implicit in this arrangement is the Government VC initiatives' ability to gain insight and influence the development of the product. In this construct, In-Q-Tel, OnPoint, and Red Planet Capital fall under the Equity Investment Model.

When In-Q-Tel was initially established, senior leadership wanted the organization to focus on early-stage COTS products because the leadership believed In-Q-Tel could then adapt the product for government use (Arlen, 2004). The aim was to identify IT areas with a high potential for dual-use. The CIA and In-Q-Tel absolutely did not want to develop new products; instead, they hoped to modify existing commercial products and enable timely technology transition. They realized that the commercial sector's concerns with the government needed to be overcome, so the "In-Q-Tel Board worked to position In-Q-Tel's evolution into a strategic venture capital Model as a way for the CIA to share risk with industry and with financial players" (Arlen, 2004). The venture capital model became a way for the CIA and In-Q-Tel to overcome their challenges in the traditional construct of customer and vendor. In-Q-Tel established the model other Government VC initiatives have attempted to copy. By having a seat on the board of each company in which it invests, In-Q-Tel gains unique insights into the problems encountered by the company and is able to provide direction and guidance. (Arlen, 2004) The CIA purposely designed In-Q-Tel to have this equity relationship because of its distinct differences from traditional acquisition procedures, and this relationship provided In-Q-Tel with rare insight and influence. (Arlen, 2004) Despite its similarity to the VC industry, In-Q-Tel is not in business to make money. It is interested in a financial return in order to be self-sustaining at some point in the future, but In-Q-Tel really uses the Equity Investment Model "as a tool to gain access to technology" (Cox & McGee, 2005, p. 48).

OnPoint's creation came out of the Army's similar need to gain access to innovative technologies. The Army studied the In-Q-Tel Model and realized its benefits. However, OnPoint was more interested in finding technologies in the latter stage of development than in mirroring In-Q-Tel's initial focus on early-stage development. This latter-stage involvement would limit financial returns, but "more important than the high ROI, is the importance of OnPoint finding companies that have a strong probability of success" (Cox & McGee, 2005, p. 65). OnPoint works with VC investors to fund, develop, and deliver technologies for industry and the government (Rottenberg, 2006). OnPoint similarly focuses on investments, but the organization stresses accelerated transition of the technology for timely delivery to the Army's soldiers (Rottenberg, 2006).

NASA hoped to gain access to the commercial source of innovation as well to improve its aerospace and biomedical capabilities; hence, it created Red Planet Capital to directly invest government money in companies that might meet its needs (Kaufman, 2006). NASA's initial vision for Red Planet Capital was an investment vehicle to support innovative, dual-use technologies (NASA Request for Information, 2006). Just as several other government agencies had, NASA recognized that the rate of innovation in the commercial sector outpaced that in the federal government. Thus, NASA structured Red Planet Capital to invest in technology using equity financing vehicles and to work with private-sector corporate and/or financial venture funds (Rottenberg, 2006). To this end, Red Planet Capital was to be led by three veterans of the VC industry, managing $75 million in taxpayer funds for a five-year period. It should be noted that, while Red Planet Capital technically falls under the Equity Investment Model, the organization is no longer affiliated with NASA. As mentioned previously, the President cut the funding for Red Planet Capital for the FY 2008 Budget.

2. Grant Model

Under the Grant Model, the government provides funds to the commercial sector to perfect mature technology or provides funds to support a public need that companies would not invest in otherwise. As opposed to the Equity Model, the government-

affiliated VC does not acquire ownership in the company. The expectation in the Grant Model is that there will be an exchange of technical expertise to develop a technology that *may* help the government. If the product does not reach maturity, the relationship comes to an end. The NTA RTVG, SBIR program, and ACIN are Grant Models.

The NTA's website states that the "primary goal of the NTA is to partner commercial technology solutions to government user technology needs and then create new or enhanced commercial products where the cost of development is leveraged across a broad user community" (National Technology Alliance, 2007). The NTA RTVG brings together universities, institutes, laboratories and commercial companies to conduct research, product development, and commercialization (Deitch, 2004). The objective of the NTA RTVG is to gain access to commercial and dual-use technology with the hope of reducing lifecycle costs. (Deitch, 2004) To achieve these goals, the NTA RTVG has partnered with over 80 leading IT organizations from the commercial, academic, and research arenas. These organizations try to provide "technology solutions and commercialization capabilities to translate science into solutions" (NTA, 2007). The goal of the NTA RTVG is to leverage the private sector's investment in the areas of Chemical, Biological, and Radiological Defense; Digital Technology Infrastructure; Geospatial Intelligence; Information Processing, Analysis and Management; and Independent Assessment and Evaluation. Under this construct, the government maintains no direct equity ownership because of the separation between the government and Rosettex; however, the government will be able to exert influence on the distribution of funds.

The next initiative in the Grant Model is the SBIR program. Many readers may be confused about the inclusion of SBIR in a discussion about VC. However, readers should realize that commercialization occurs in Phase III of the SBIR program. During Phase III, private-sector investors are able to support the technology and bring it to the market. Often, this phase deals with VC. In fact, a study was conducted at Harvard University in 1996 that concluded "that the SBIR program has had a positive long run impact in areas where venture capital is available" (Cooper, 2003, p. 140). This positive impact is because SBIR fills a specific gap; the study explains that "gap is at the seed and start-up stages where many new ventures must rely on their own money or on personal

contacts, and before the project has developed to the point that an angel or venture capitalist is interested" (Cooper, 2003, p. 140). As Lerner points out, the SBIR program is a public venture capital program because it fills the need for financing where the private market has not adequately funded an innovative activity (Cooper, 2003). The SBIR program is a perfect example of the Grant Model. While SBIR is a significant source of funding for early-stage small businesses (Harcum, 2003), federal agencies select the focus areas for SBIR that support public program goals (Cooper, 2003).

The Army uses a different mechanism to further its public program goals—the Applied Communication Information Networking (ACIN) program. The ACIN Camden Center for Entrepreneurship in Technology fosters "growth in private-sector companies that are developing new technologies and products to be used in military and commercial applications" by serving as "a full-service technology accelerator program designed to assist small companies" (ACIN, 2007). How does ACIN foster growth? What is a full-service technology accelerator program? The ACIN program is an incubator for small companies. As an incubator, ACIN fosters growth: by providing a plug-and-play environment where small businesses have access to office and communications equipment; by offering mentoring, coaching, and management expertise to support small businesses' strategy, intellectual property management, and marketing; and by surrounding the small businesses with knowledge from other defense contractors (ACIN, 2007). The hope is that all of these services will "accelerate the formation and growth of early stage technology ventures" (ACIN, 2007) that might mature, commercialize, and have capability desired by the Army. ACIN had 900 incubator contractors as of 2005. These contracts are simple: "Companies get office space and entrepreneurial advice, while the military gets a first look at whatever technology emerges," and "successful research programs are transitioned to small businesses for production" (Deitch, 2005, p.19).

3. Communication Catalyst Model

Communication Catalysts do not provide any funding to the commercial sector. The purpose of the Communication Catalyst Model is to establish and support

communication forums for the VC and the government's acquisition communities. government funding supports the organic resources of its agencies to support these efforts. However, Communication Catalysts facilitate a "meeting of the minds" between venture capitalists, the commercial sector, and the government's acquisition community. Successful technology transition is dependent on the government's acquisition community successfully budgeting for these technologies. The Navy's CTTO and its VCs @ Sea program (as well as DeVenCI) are Communication Catalysts.

The mission of the Navy's CTTO, according to its website, is to rapidly transition the best technologies from any source into Department of the Navy programs (Office of Naval Research, 2007). The CTTO's process for transitioning these technologies is effectively to be a "matchmaker" or "deal broker" between industry and Naval Acquisition Programs. This process is depicted in Figure 14 below. Clearly, the CTTO is a Communication Catalyst—as evidenced by the fact that the organization brings together VCs and warfighters in order to enhance information and identify potential areas of shared value—a proving ground and customer for the VCs and improved capability for the warfighter (Lawlor, 2003).

Figure 14. CTTO Process [From ONR website, 2005]

In addition to being a "deal broker," the CTTO sponsors the Naval Research Advisory Committee (NRAC) Venture Capital Technology Panel. In its roadmap process, the panel developed an intriguing method to identify emerging technologies—the VCs @ Sea program.

The first instance of the VCs @ Sea program occurred from January 19 to 21, 2003, off the California coast. The CTTO granted leading venture capitalists access to aircraft carrier and fleet operations during Exercise Transparent Hunter. The VCs explored the aircraft carrier USS Nimitz and the Third Fleet's flagship USS Coronado to understand the Navy's technology operations and needs (ONR, 2003).

The VCs @ Sea program was operated as one of the CTTO's "venture initiatives." There is no equity investment or grant funding. While the overall goal of the CTTO is to bring VCs and warfighters together, the VCs @ Sea initiative made this goal a reality by establishing a forum for VCs and warfighters to brainstorm together and learn to speak a common language. (ONR, 2003) Unfortunately, the VCs @ Sea program has been discontinued due to budget constraints, but the Communication Catalyst Model had a lasting impact, which can now be found in the Defense Venture Catalyst Initiative.

DeVenCI is the latest VC initiative and has a very similar goal to the CTTO's mission. DeVenCI focuses on emerging technologies and uses various methods to increase awareness within the DoD of these emerging technologies. (Defense Venture Catalyst Initiative, 2007) DeVenCI structured itself similarly to the CTTO-to "broker" information exchanges between the DoD and small, innovative companies (DeVenCI, 2007). The purpose of brokering is to identify emerging technologies that meet a current warfighter need. The DeVenCI Model is depicted in Figure 15.

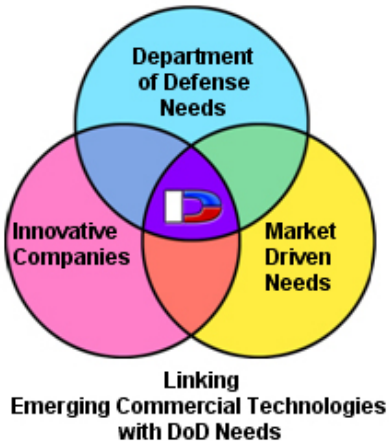

Figure 15. The DeVenCI Model [From DeVenCI, 2007]

DeVenCI does not provide any direct funding to the VC industry. According to DeVenCI, the initiative is a catalyst for improved communication between warfighters and small, innovative companies. (DeVenCI, 2007) DeVenCI is supported by 11 venture capitalists that volunteer to help foster communication and collaboration. The VCs volunteer their time and knowledge in order to improve the government's ability to interact with these small, innovative companies. (DeVenCI, 2007). Communication forums are created by an offering of workshops, technology expositions, industry outreach, and web access.

The range of initiatives along the spectrum displays the many different approaches for facilitating the exchange of information between the VC industry and the government to enhance R&D. The next section, which will provide quantitative data on the Government VC initiatives' activities, provides a similar breakdown as the VC. This data will answer the research questions about the investment trends of the Government VC initiatives.

D. VC PORTFOLIO

We assess the VC portfolio according to similar areas defined in the VC industry by: resources, investments, companies, exits, and performance. These areas include the Government VC initiatives broken down by the spectrum: Equity Investment, Grant, or Communication Catalyst. The portfolio includes all the organizations along the spectrum defined in the previous section. This section will try to compile the various Government VC initiatives into one portfolio to get a macro-view for further analysis.

1. VC Initiative Resources

The Government VC initiatives have different sources of funding from various government agencies. The use of the government funds depends on where the VC initiative lies along the spectrum. Most of the Government VC initiatives have their main office in Northern Virginia, but have affiliated organizations spread across the U.S.. We will first assess the Equity Investment Models.

a. Equity Investment Model

OnPoint and In-Q-Tel are the Government VC initiatives in current operation that make equity investments. Since its inception in 2002, Onpoint had received $61.8 million as of May 2006 (Palmer, 2006). On the other hand the CIA provides investment capital to In-Q-Tel with an annual contract between $30 and $37 million (Lerner, Hardymon, Book, & Leamon, 2004). However, according to Lacy (2005), In-Q-Tel's annual budget increased from about $27 million to $60 million with new funds from other agencies within the intelligence community, such as the National Geospatial Intelligence Agency (NGA). With these dollar amounts, we can estimate the total capital under management since the organization's inception.

The total capital under management for OnPoint is about $61.8 million since it opened for business in 2003 (Palmer, 2006). On average, OnPoint's capital under management per year was about $12.36 million. In-Q-Tel's total capital under management is about $360 million since its inception in 1999. This amount is estimated using $30 million from 1999 to 2004 and $60 million from 2005 to 2007 based on the estimates by Lerner et al. (2004) and Lacy (2005). On average, In-Q-Tel's capital under management per year was about $40 million. The government provided about $421.8 million in total capital for investment for OnPoint and In-Q-Tel throughout 1999 to 2007. In addition to analyzing the capital under management, we can assess these Government VC initiatives according to their geographic locations.

OnPoint is located in Winter Park, Florida, and its creator, MilCom Technologies, is also located in Florida. In-Q-Tel's main office is in Arlington, Virginia, but it has another office in Menlo Park, California. The office in California houses In-Q-Tel's strategic investment team, which operates similar to a corporate strategic venture capital firm (In-Q-Tel, 2007). The next category, the Grant Model, will assess the resources for SBIR, the NTA RTVG, and ACIN.

b. Grant Model

SBIR receives funds from various government agencies, but we will only assess the DoD's SBIR program. The NTA RTVG receives funds from NGA, which is the executive agency for the NTA. ACIN receives funds from the Army through a partnership with Drexel University. In 2006, the DoD's SBIR budget totaled $1,133,774,407 (DoD SBIR, 2007). The following figure breaks down these figures by each agency inside the DoD:

DoD Component	SBIR Budget ($)
Army	243,357,000
Navy	309,665,000
Air Force	313,040,506
DARPA	67,018,000
DTRA	6,579,000
MDA	118,843,000
SOCOM	14,133,000
CBD	10,212,000
OSD	50,478,000
NGA	448,901

Figure 16. SBIR Budget for 2006 [From SBIR, 2007]

In 2006, according to the DoD's *Annual Report on Cooperative Agreements and Other Transactions*, the NTA RTVG was awarded $13,218,365, while ACIN was awarded $20 million for three years. The NTA RTVG received awards for various acquisition transactions for prototype (DoD, 2007). Back in February 2002, the NTA RTVG received a contract for five years worth up to $200 million from NGA (Caterinicchia, 2002). In 2006, the DoD's SBIR, the NTA RTVG, and ACIN had $1,166,992,772 in total funds under their management.

SBIR offices for the DoD are located in Arlington, VA. The NTA RTVG's main office is also located in Northern Virginia. However, the NTA RTVG's team consists of leading research universities, institutes, laboratories, and commercial

companies with facilities in 34 states and across the globe (Rosettex, 2004). Even though the main office for DoD SBIR programs is in Northern Virginia, personnel there examine proposals from across the nation. The ACIN technology center is located at the Waterfront Technology Center in Camden, NJ, but it also has strong relationships with Drexel University, Rutgers University, University of Pennsylvania, Rowan University and other academic institutions. This relationship provides access to intellectual capital, including professors, researchers, and students in technology, engineering, and management (ACIN, 2007). The last category assessed for the Government VC resource area is the Communication Catalyst Model.

c. Communication Catalyst Model

DeVenCI receives funds from the DoD to run its office. DeVenCI's budget for 2007 was about $3 million (Lais, 2007). According to the Office of the Secretary Defense's RDT&E project justification from February 2007, DeVenCI's proposed budget for FY 2008 is $3.9 million, increasing up to $4.7 million for FY 2009. DeVenCI's funds are used mostly for its workshops, which bring the DoD's acquisition community together with innovative companies found by the VC Industry (Lais, 2007).

DeVenCI consists of a small team located in Northern Virginia. However, it employs 11 consultants from the VC Industry in various parts of the country. These VC consultants are experts in their fields and have first-hand knowledge of new emerging technologies in the private sector. This assessment on VC resources provides a necessary foundation for the assessment on Government VC initiatives' investments to follow.

2. VC Initiative Investments

We will breakdown the investments for the Government VC initiatives by their associated industry sector and funding stage or phase. The categories for the different stages are startup-seed, early, expansion, and latter. These stages will be used in the next section to describe the investments made by Government VC initiatives under Equity

Investment Model. This section also includes a breakdown of the average age of the companies, as well as their investments and the geographic concentration of these investments.

a. Equity Investment Model

In-Q-Tel's investments focus around three areas: software, infrastructure, and physical sciences (In-Q-Tel, 2007). These areas are related to the following industry sectors: computer software, computer hardware and services, semiconductors and electronics, biotechnology, communications, and industrial/energy. OnPoint's main investment focus areas are mobile power and energy-enabling technologies, which both fall under the industrial/energy sector (OnPoint, 2007). In-Q-Tel does not concentrate on any one particular stage, but its track record has shown investments in startup-seed and early-stage companies (Tighe, 2007). OnPoint also does not concentrate on a particular stage because its strategic focus allows it to invest at any stage of development (Cox & McGee, 2005).

In 2004, In-Q-Tel averaged a deal about every other week—ranging from $500,000 to $3 million. From 1999 to 2005, In-Q-Tel invested in 77 transactions averaging almost 13 investments per year (Lacy, 2005). OnPoint's typical investments range from $500,000 to $2.5 million, and it makes between four to six investments each year (Cox & McGee, 2005). Both OnPoint and In-Q-Tel either lead investment rounds or co-invest with other firms. The following figures show the investments' geographic concentration and the average age of the invested companies. The figures are derived using data from In-Q-Tel and OnPoint's website. There was no data for the age of OnPoint's invested companies. However, OnPoint started operations in 2003; so at most, the average age of its investments is about 3.5 years.

CA	25	42%	MD	1	2%
CO	4	7%	MN	2	3%
CT	1	2%	NC	1	2%
FL	1	2%	NM	1	2%
GA	1	2%	NV	1	2%
ID	1	2%	OR	2	3%
IL	1	2%	RI	1	2%
MA	7	12%	VA	8	13%
MI	1	2%	Canada	1	2%
			Total	60	100%

Figure 17. In-Q-Tel Investment % by Geographic Location

CA	5	50%
MA	2	20%
MO	1	10%
VA	1	10%
UK	1	10%
	10	100%

Figure 18. OnPoint Investment % by Geographic Location

In-Q-Tel

	# of Companies	Average Age (month)	Average Age (yrs)
Private (invested in)	50	36	3.0
Public (invested in)	2	48	4.0
Acquired (date invested to date acquired)	6	31	2.6
Private (Strategic Partnerships)	2	41	3.4
Total	60		

Figure 19. In-Q-Tel: Average Age of Portfolio Companies as of August 2007

b. Grant Model

The NTA RTVG, ACIN, and the DoD's SBIR focus their funds or resources mostly in the information technology sector. The NTA RTVG focuses on geospatial intelligence (GI) technology, information processing, analysis and management (IPAM) technology, digital technology infrastructure (DTI), and independent assessment and evaluation activities (Rosettex, 2004). ACIN is providing

resources for areas such as voice-over IP (VoIP) tracebook, modeling and simulation, high-power amplifiers, and intelligent agent feasibility for future tactical networks (ACIN, 2007). The DoD's SBIR focuses on areas such as ultra-wideband imaging array surveillance sensors, caching software updates over a wide-area network, and cognitive radio capability for software-defined radios (DoD SBIR, 2007).

The DoD's SBIR funds are capped at $100,000 for phase one and $750,000 for phase two. The following figures break down the total awards funded for each phase in 2006 and the top five states receiving DoD SBIR from 2001 to 2004:

DoD Component	# Topics	# Ph I proposals	# Ph I awards	# Ph II awards
Army	238	3,384	352	390
Navy	187	2,498	446	232
Air Force	285	4,275	577	312
DARPA	23	427	25	48
DTRA	13	127	23	17
MDA	54	1,165	174	119
SOCOM	17	266	49	5
CBD	10	149	17	9
OSD	55	955	197	39
NGA	1	7	2	1
All DoD	883	13,253	1,862	1,172

Figure 20. DoD SBIR Phase I & II Awards, 2006
[From SBIR, 2007]

(Dollars in millions)

State	Phase I applications - number and percentage	Total awards - number and percentage	Total dollars awarded - number and percentage
California	10,584 (21%)	2,433 (22%)	$741 (23%)
Massachusetts	6,173 (12%)	1,568 (14%)	$483 (15%)
Virginia	3,787 (7%)	825 (8%)	$245 (7%)
Ohio	2,022 (4%)	485 (4%)	$163 (5%)
Colorado	1,956 (4%)	543 (5%)	$160 (5%)

Figure 21. DoD SBIR Phase I Awards by Geographic Location, 2001 to 2004
[From SBIR, 2007]

ACIN and the NTA RTVG's funds are not separated into different phases as they are with SBIR. ACIN is a technology incubator that provides resources instead of funds to startup companies. The NTA's funds go directly to RTVG, which invests any profits from management and development into an independent venture fund (Deitch, 2004). This independent venture fund provides startup-seed and early-stage investments (Rosettex, 2004).

c. Communication Catalyst Model

DeVenCI's main focus area is in the information technology sector. Within this sector, DeVenCI is interested in areas such as identity management, information assurance, network operations, data sharing, network components, and systems architecture (DeVenCI, 2007). DeVenCI examines all companies from startup-seed to later stage. The initiative does not make investments in any companies. The next section will list the actual companies, universities, or laboratories that compose the Government VC portfolio.

3. VC Initiative Portfolio Companies

The Government VC initiatives have a diverse portfolio of companies with which they each work with. The majority of the companies are small, largely unknown companies. These companies were unknown to the government prior to the VC initiatives. Some portfolios are bigger than others, so we will not list all the companies for the larger portfolios. The next section covers the VC initiative companies under the Equity Investment Model.

a. Equity Investment Model

In-Q-Tel's portfolio contains about 60 emerging companies and three innovative partnerships with established companies, public and private laboratories, and universities (In-Q-Tel, 2007). OnPoint, in contrast to In-Q-Tel, only has 10 companies in its portfolio (OnPoint, 2007). The difference can be due to the age of the firm, management's objectives, or difference in investment focus areas.

In-Q-Tel

- **Pixim:** Develops imaging platform that produces higher quality moving and still images. www.pixim.com
- **Infobionics:** The Cellular Database Management System™ that delivers an unprecedented combination of flexibility and performance data search and analysis. www.infobionics.com
- **TenXsys:** Specializes in remote monitoring of health and location for humans and animals. www.tenxsys.com
- **Initiate Systems:** Specializes in entity resolution and information sharing about persons, organizations, objects, and events. www.initiatesystems.com
- **Adaptive Energy:** Is the leading innovator of miniature piezo actuators and generators. www.adaptiveenergy.com

Note 1: The companies listed above are the most recent investments.

Note 2: See Appendix A for complete list of In-Q-Tel's portfolio companies.

OnPoint

- **Nanosolar:** Developers thin-film solar technology for roll-to-roll printing of solar cells on flexible substrates. www.nanosolar.com
- **PowerGenix:** Develops next-generation rechargeable batteries. www.powergenixsystems.com
- **UltraCell:** Develops and sells integrated fuel cell systems. www.ultracellpower.com
- **Zinc Matrix Power:** Develops high-performance, rechargeable alkaline battery technology for commercial and military market. www.zmp.com
- **Superprotonic:** Is an energy technology company that markets and commercializes the innovative solid acid fuel cell technology developed and patented by the company's founders at the California Institute of Technology. www.superprotonic.com
- **A123:** Develops advanced Lithium-ion-based cells for rechargeable battery packs. www.a123systems.com
- **Integrated Fuel Cell Technologies, Inc.:** Develops next-generation fuel cell systems; will address the global fuel cell market for portable devices.
- **Akermin:** Develops and commercializes portable fuel cells based on its proprietary "Stabilized Enzyme Biofuel Cell" technology. www.akermin.com

- **PowerPrecise:** Is a Fabless semiconductor company specializing in battery management devices.
- **Atraverda:** Develops advanced bi-polar battery electrodes for rechargeable batteries. www.atraverda.com

b. Grant Model

The DoD's SBIR portfolio includes 1,862 companies that received Phase-I funds and 1,172 companies that received Phase-II funds in 2006 (DoD SBIR, 2007). The NTA RTVG manages a team of more than 75 leading information technology organizations (Rosettex, 2004). This team can be viewed as companies in the NTA RTVG's portfolio. ACIN's portfolio consists of 36 companies that utilize ACIN's full-service, emerging technology incubator/accelerator program (ACIN, 2007). The list below only contains a few companies due to the large size of these portfolios.

SBIR

- **Nanosonic, Inc.:** Demonstrates improvements to broadband transmissions by targeting desired waveband and optical transmission specification.
- **Anza Corp.:** Develops satellite optical communications modules.
- **Microcosm, Inc.:** Provides generic adaptive approaches for orbit and attitude determination on earth-pointing spacecraft.
- **Fiber Materials, Inc.:** Develops advanced, low-cost, non-eroding material systems based on carbon filter reinforced with carbon silicon carbide for high performance divert and attitude control system components.
- **Razor Technologies, Inc.:** Develops and demonstrates a total hypergolic propellant leak detection system.

NTA RTVG

- **Ashland Institute:** Offers independent needs analysis outreach, technology assessment and evaluation
- **SYNTEK Technologies:** Offers independent needs analysis outreach, technology assessment and evaluation
- **Purdue University:** Provides technology research, development and prototyping
- **Motorola:** Provides technology research, development and prototyping

- **HP Invent:** Specializes in product development and commercialization
- **InPhase Technologies:** Specializes in product development and commercialization
- **Lockheed Martin Corporation:** Specializes in technology Insertion and System Integration
- **IBM Consulting:** Specializes in technology Insertion and System Integration

Note 1: See Appendix A for a complete list of the NTA RTVG's team.

ACIN

- **Gestalt, LLC:** Develops practical, yet innovative solutions that drive competitive advantage in complex decision environments.
- **USFalcon:** Service-disabled, veteran-owned, minority business enterprise that offers information technology solutions, operations and logistics solutions, professional engineering solutions, security and intelligence solutions, and business analytical services.
- **Smarter Agent:** Combines mobile location technology, such as GPS, with information about real estate, neighborhoods, and interesting places.
- **Iridian Technologies:** Leads the world in research, development and marketing of authentication technologies based on iris recognition—the most accurate biometric identifier.
- **ENI Systems:** Offers smart-card and biometric solutions for physical access, public key infrastructure, and custom software solutions.

Note 1: See Appendix A for a complete list of ACIN's portfolio companies.

c. Communication Catalyst Model

DeVenCI does not have a portfolio of invested companies, but its portfolio consists of 11 private VC consultants. The list below contains the selected private VC consultants with their respective VC firms for 2006.

- Mr. Tom Banahan (Lehman Brothers Venture Partners)
- Dr. James Barrett (New Enterprise Associates)
- Mr. Kevin Fong (Mayfield Fund)

- Mr. Wilber James (RockPort Capital Partners)
- Mr. Mark Kvamme (Sequoia Capital)
- Mr. Jeb Miller (ComVentures)
- Mr. Roger Novak (Novak Biddle Venture Partners)
- Mr. Don Rainey (Intersouth Partners)
- Mr. Morgan Rodd (Arrowpath Venture Partners)
- Mr. Ted Schlein (Kleiner Perkins Caufield & Byers)
- Mr. Robert Simon (Alta Partners)

The portfolios for each Government VC initiative are unique and do not only include equity-investment companies, but also include strategic partnerships, private VC consultants, universities, established public companies, and public and private laboratories. Some companies in the Government VC portfolio have either gone public or been acquired by other public companies; this trend is discussed further in the next section.

4. Exits (IPOs and Acquisitions)

The Government VC initiatives' goal is not financial returns. Thus, company exits through IPO or acquisition is not important. However, some initiatives' returns on investments go toward future projects, operations, or an employee investment plan. The only Government VC initiatives that are directly involved with IPOs or acquisition are In-Q-Tel and OnPoint, due to their equity investment.

The 10 companies in OnPoint's portfolio are still private, and there is no information regarding any acquisition of OnPoint's invested companies. However, some of In-Q-Tel's invested companies were acquired or achieved IPO. This section only assesses the exits involved with In-Q-Tel because the Government VC initiatives under the Grant and Communication Catalyst Models are not directly involved with IPOs or acquisitions.

We found that two companies achieved IPO; six of In-Q-Tel's invested companies were acquired. This record dates from the inception of In-Q-Tel in 1999. Another company in In-Q-Tel's portfolio is also planning to file for IPO: 3VR Security CEO and co-founder, Stephen Russell, announced 3VR may file for an IPO in less than two years (Bak, 2007). The figure below describes each IPO and acquisition with information obtained from In-Q-Tel's website, SEC filings, or news articles.

IPO	Date of Investment	Date of IPO/ Acquisition	Stock Price (8/23/07)	Total Shares issued	Exercise Price	Acquiring Public Company
Ionatron (stakes liquidated in March 2005)	Oct-03	Apr-04	$ 3.45	725,000 (see Note A)	0.69	N/A
Electro Energy	Mar-04	Apr-05	$ 0.68	118,066 (see Note B)	$3.11	N/A
Acquisition						
Decru	Oct-03	Jan-05	N/A	N/A	N/A	Network Appliance
Keyhole	Feb-03	Oct-04	N/A	N/A	N/A	Google
Soflinx	Mar-03	Dec-04	N/A	N/A	N/A	Lockheed Martin
@ Last Software	Jul-04	Mar-06	N/A	N/A	N/A	Google
SRD	Jan-01	Jan-05	N/A	N/A	N/A	IBM
Visual Sciences	Mar-04	Dec-05	N/A	N/A	N/A	WebSide Story

Notes:

A-Original agreement was for In-Q-Tel to pay $500,000 for about 1.03 million shares, but In-Q-Tel decided to liquidate and agreed to 725,000 shares (75% held by company and 25% to employee fund) and liquidated its stake in March 2005 at about $10 per share (Byron, 2005).

B-The 118,066 is split between 90,632 shares of unregistered common stock and 27,434 warrants for the $300,000 received from In-Q-Tel in connection with original stock purchase agreement. The original stock purchase agreement was for 241,692 shares of unregistered common stock and warrants to purchase 75,829 shares of unregistered common stock at $3.11 per share. Total purchase price is $800,000, expected to be paid over 14 months following the closing (SEC, 2007).

Figure 22. In-Q-Tel IPO & Acquisition Data, 2001 to 2006

5. VC Initiative Performance

Performance for Government VC initiatives is not measured by financial returns as it is for the VC industry. Government VC initiatives' performance is based on both tangible and intangible items. A tangible item is the return on technology or new innovative technology that is successfully transferred into the government. Intangible items are the social networks created with the VC industry and new emerging innovative companies. Most initiatives are too young for their return on technology to be accurately measured, but there are signs of success. However, the social network is just as important because without it, the government is back to conducting closed innovation. We assess the Government VC initiatives' performance, beginning with the Equity Investment Model.

a. Equity Investment Model

In-Q-Tel and Onpoint's funds leverage $8 from the private sector for every $1 they invest (Palmer, 2006). This leverage helps them lower both development costs and total lifecycle costs (Cotell, 2006). OnPoint opened for business in 2003, and it already has one key success. One of OnPoint's companies, PowerPrecise Solutions, developed a low-cost, state-of-charge-indicator for the BA-5590 primary, non-rechargeable battery. The Army fielded 10,000 units of this new technology within two years, and OnPoint expected more than 100,000 fielded units by the end of FY 2006. According to the Army Audit Agency Report, the projected cost savings on this new technology's was over $375 million for the entire DoD (Rottenberg, 2006). In-Q-Tel's performance speaks for itself.

According to In-Q-Tel's website, it has delivered more than 140 technology solutions, engaged with more than 90 companies (previously unknown to the government) and more than 10 universities and research labs. In-Q-Tel reviewed more than 6,000 business plans, and its social network consists of more than 200 VC firms and 100 labs and research organizations (In-Q-Tel, 2007). In addition to its return on technology and social network, In-Q-Tel's return on investment allowed it to reinvest about $15 million in future projects (Cotell, 2006).

An example of In-Q-Tel's return on investment was Ionatron's move to go public in 2004. Ionatron sold In-Q-Tel a warrant to buy $500,000 worth of stock for less than one dollar per share. In-Q-Tel sold its stake in Ionatron in 2005 for more than $5 million, according to SEC filings. In-Q-Tel was criticized for a "pump-and-dump" scheme; however, In-Q-Tel's relationship with Ionatron ended a year before the stock was sold. The profits went towards future investments, an employee investment plan (independent of In-Q-Tel and benchmarked to industry average), and a donation to the CIA Officers' Memorial Foundation (O'Hara, 2005).

In-Q-Tel also made a return on investment when it sold 5,636 shares of Google, worth over $2.2 million on November 15, 2005. The stocks were a result of Google's acquisition of Keyhole from In-Q-Tel (Hoover, 2006). According to Louie (2007), In-Q-Tel turned a $50,000 investment in Keyhole into $5 million. In-Q-Tel's equity investment is only about 20% of the total funds given to each company it invests in to obtain warrants (rights to buy stocks at a certain price). The other 80% is used for buying licenses, technology modifications for government use, and to fund future technology development. In-Q-Tel is able to obtain warrants at a low price while the company claims 80% of In-Q-Tel's funds as revenue. At the beginning of 2006, In-Q-Tel had an internal rate of return (IRR) around 26-27% from only its equity portion of the investments. This IRR placed In-Q-Tel among the top 10% of all VC funds. (Louie, 2007)

b. Grant Model

The DoD SBIR's performance can be measured either by the success stories or whether the program is meeting SBIR guidelines. For example, SBIR-related products account for about 25% of II-VI Inc.'s revenues that currently exceed $60 million (DoD SBIR, 2007). However, SBIR's performance can not be solely measured on success stories. SBIR has guidelines to meet; the Government Accountability Office (GAO) conducted a report on DoD's SBIR in April 2006.

The GAO report found most of the awards were concentrated in a few states. California and Massachusetts received about a third of all SBIR awards and total

dollars awarded. About 12% of DoD SBIR awards exceeded guidelines and accounted for 23% of the dollars awarded by the DoD. The additional amount was either used to ensure higher-quality investigations or included non-SBIR funds, such as mission funds.

Half of the firms that received DoD SBIR awards had 20 employees or less, but firms that also received venture capital investment were about 30% larger. The GAO also found that the DoD awarded a higher amount for Phase I to companies with venture capital investments. However, only 7% of total dollars awarded (or $218 million) went to companies with venture capital investment. ACIN is the next organization we assess as a Government VC Grant.

ACIN's performance can be measured by its social network—that includes international participation from New Zealand and Israel Technology and their mentoring partners: General Dynamics, CACI, Verizon FNS, Galaxy Scientific, Lucent, Lockheed, and Booz Allen. Another measure of ACIN's performance is by government contracts awarded to small businesses in its portfolio. For example, Gestalt Corp received a $53.3 million defense grant in April 2006. Gestalt's CEO hoped to produce and field test a product to protect against improvised explosive devices within 90 days. USfalcon is another company associated with ACIN that received an award (along with six other prime contractors) for $19.25 billion over 10 years to support the Strategic Services Sourcing Program. The NTA RTVG is the last organization to assess before we assess the performance of Government VC initiatives that fall under the Communication Catalyst Model (ACIN, 2004).

In 2004, the NTA RTVG had 35 orders in less than two years—with a value of approximately $43 million (Deitch, 2004). We can also measure the NTA RTVG's performance based on the government awards received. In 2006, according to the DoD's *Annual Report on Cooperative Agreements and Other Transactions*, the NTA RTVG received 17 awards totaling $13,218,365. The NTA RTVG's social network with the 75 leading information technology organizations is a significant, though intangible, measure of the NTA RTVG's performance.

c. Communication Catalyst Model

DeVenCI is another young organization, so it is too early to measure its performance based on technology transitioned into the DoD. However, DeVenCI has a powerful social network consisting of 11 venture capitalists from the private industry. These 11 venture capitalists typically find 30 companies within six weeks to present to the DoD's acquisition community. These are companies with break-through technology unknown to the DoD. However, DeVenCI also introduces well-known companies (such as Google) that have never worked with the DoD. Google personnel taught several agencies about the Google search engine (Lais, 2007). As previously mentioned, intangible items such as social networks are just as important as returns on technology or investment in measuring performance. The assessment of the VC industry and Government VC initiatives, though obviously not conclusive, does solve more of our research questions . This leads into our next chapter on the *QDR*—an investigation of whether or not the Government VC initiatives are investing in the areas addressed in the *QDR.*

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IV. QUADRENNIAL DEFENSE REVIEW

A. OVERVIEW OF *QDR*

A chapter dedicated to the *QDR* in the context of VC may seem unexpected in this discussion, but simple qualitative analysis of the *QDR* suggests VC could be ideal for defense modernization. First, what about the *QDR* makes it important for VC? The *QDR* could be considered the archetypal public document which enumerates the "gaps" between current and desired defense capability. Title 10 USC 118 specifies the Secretary of Defense must perform a periodic review to include a:

> National defense strategy, force structure, force modernization plans, infrastructure, budget plan, and other elements of the defense program and policies of the United States with a view toward determining and expressing the defense strategy of the United States and establishing a defense program for the next 20 years. (Title 10 USC 118)

The *QDR*, as a public document, ideally positions those capability gaps for the VC community's consideration. That is, VC entities and entrepreneurs alike can align their interests to a very solvent customer: the DoD. The VC community thrives off of networking and partnering to allocate funding and find viable entrepreneurial candidates. "Many financial markets are characterized by strong relationships and networks, rather than arm's-length, spot market transactions" (Hochberg, Ljungqvist, & Lu, 2007, p. 251). The *NVCA Yearbook*'s charts and tables suggest information technology (IT) and medical innovation are arguably the two most prominent areas of VC investment (2007a). VCs can certainly help here, but the *QDR* specifies more areas than IT and medical needs. The DoD can harness the power of the VC industry's infrastructure to narrow its capability gaps. Moreover, the DoD can probably close these gaps in a more expedient, economical fashion than can traditional R&D agencies.

Finding the *QDR*-defined capability gaps required the researchers to filter the entire document to extract relevant portions containing implications for DoD needs on the

VC industry. What exactly are the criteria for a "relevant" portion of the *QDR*? Here is an explanation of the criteria we used, with an actual excerpt from the 2006 *QDR* as an example of each:

1. Specific dollar amounts for future investment.
    a. EXAMPLE: The Department is further increasing funding for the Chemical Biological Defense Program (CBDP) by an additional *$2.1 billion* (p. 51).
2. Declared areas of increased investment, even if a dollar amount is not stated.
    a. EXAMPLE: Make additional investments in information assurance capabilities to protect information and the Department's computer networks (p.50).
3. Generalizations about future capabilities.
    a. EXAMPLE: Capabilities to locate, tag, and track terrorists in all domains, including cyberspace (p. 52).
4. Reformations, modernizations, paradigm shifts, and DoD internal studies.
    a. EXAMPLE: From an emphasis on ships, guns, tanks and planes—to focus on information, knowledge and timely, actionable intelligence. From massing forces—to massing effects (p. vii).

After condensing these portions from the QDR, we identified commonalities in the investment recommendations, capabilities studies, and reformation initiatives. We then grouped similar items together. Finally, we organized the groups into an outline, presented here:

I. DoD Overall Goals
II. Key portfolio areas:
    a. Information Technology
    b. Medical/Biological
    c. Intel & Surveillance
    d. Language & Cultural skills
    e. Logistics
III. Result—Cost Minimization and Innovation

For the purpose of efficiency, the QDR sentences and phrases are located in Appendix B. Below, we summarize the conglomeration of what we found in the document itself.

1. DoD Overall Goals

At several points, the QDR suggests that the DoD must increasingly use innovation to achieve its vision for the next 10 to 20 years. The theme will not be "business as usual." The DoD emphasizes the need to be light and lean today, while anticipating future capabilities and acquiring them early. The Department's turning to VC will arguably result in earlier acquisition of these missing capabilities. Venture capitalists have a vested interest in prodding their entrepreneurs to deliver what is promised in their business plan. Of course, one of VC's hallmarks is urging entrepreneurs to make progress so investors may exit an investment. The DoD is not pursuing just the financial reward of VC, but also the potential for increased capability to put systems in the warfighters' hands.

2. Information Technology

We identified nine references in the QDR pertaining to enhanced IT capabilities. Specific references are detailed in Appendix A; however, we identified aggregate needs in the following areas: network protection, communication, information protection, and cyber-warfare. For network protection, the DoD needs to "defend and protect information and networks" (p. 59). The QDR makes several references to the importance of real-time information-sharing among the joint and international forces. Other key areas in which VC could provide a capability include: protecting information systems from electromagnetic pulse, augmenting the Global Information Grid (GIG), developing software to locate, tag, and track terrorists, and securing broadband communications. The QDR specifies several IT needs for the future; serendipitously for the DoD, this is the VC industry's top area of expertise.

3. Medical/Biological

We identified six references in the QDR pertaining to enhanced medical/biological capabilities. Of the six references, five specifically called for medical countermeasures against biological agents, pathogens, and viruses. Rosenburg suggests this heavy investment in countermeasures is necessary and worthwhile. "Not to develop defenses against conceivable biological and chemical weapons […] entails risk […] no defense against biological and chemical weapons can be fully satisfactory" (1985, p. 120). Evidently, in the spirit of Rosenburg's quote, the DoD believes in moving forward—it is dedicating $1.5B for medical countermeasures over the next five years.

4. Intelligence and Surveillance

We found eight references concerning intelligence and surveillance matters. The QDR discusses these in vague terms, with no specific dollar amounts mentioned. Capabilities defined here include: information fusion, synthetic aperture radar capabilities, and rapid data/rapid reaction, an "unblinking eye" over battlespace, and air /maritime domain awareness. Tomorrow's focus is on real-time data, which is easily common among forces in the field; this leads to a coordinated attack on the enemy. That is, "good" intelligence only has value for a short time, and the warfighter must have the capability to receive that information and exploit it as soon as possible.

5. Language and Cultural Skills

We found two QDR references emphasizing the importance of investing in language and cultural skills. The most significant factor impacting language and cultural skills is the changeover from the Cold War to the Global War on Terrorism (GWOT). Lt. Col. Deborah Hanagan, the Chief of Staff of the Defense Language Institute Foreign Language Center (DLIFLC), said, "Our military missions are so different today than they were during the Cold War, when Russian and other East European languages were our largest programs" (Cutter, 2007, ¶ 3). The current Iraq and Afghanistan conflicts caused a surge in demand for Arabic, Dari, and Pashto. Entrepreneurs have many opportunities to create dual-use technologies to hasten the learning process. At the DFIFLC,

technology plays a big role in the classroom because the younger generations are used to having access to information at their fingertips. Classrooms have interactive white boards; educators issue students MP3 players or iPods, and are proving them with tablet PCs (Cutter, 2007). Language and cultural learning technologies may not win the Nobel Prize like medical breakthroughs, but they will enable the DoD to accomplish its mission.

6. Logistics

We found only one quote about logistics. It emphasizes the DoD should pursue enabling technologies for transformational logistics and innovative operations such as seabasing.

7. Cost Minimization and Innovation

We found six *QDR* references suggesting a desired end-state for the technological breakthroughs in information technology, medical/biological, intelligence/surveillance, language/cultural skills, and logistics. From these "end-state" quotes, we distilled two main results: 1) cost minimization and 2) innovation. Even though the DoD is doing everything in its power to make it as unfair a fight as possible for its enemies, it still must operate with a finite budget. This is a challenge when the DoD's list of responsibilities seems to keep expanding, and the enemy keeps getting smarter. Simultaneously, the DoD must invest billions in research and development—which might be fruitless—and find more innovative ways to get its job done.

We analyze the data we collected in the next section. Specifically, we: 1) determine differences, as well as the advantages and disadvantages, of the various Government VC initiatives, 2) compare and contrast the investment portfolios of the VC industry vs. the Government VC initiatives, and 3) determine if the VC industry provides a relevant source for government R&D.

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V. ACKNOWLEDGEMENTS

The research for this project yielded potential arguments against the various DoD VC models. This paper does not adequately deal with all of these arguments, but it is important to recognize the objections and potential challenges for employing these models. We recommend further research be conducted to answer these arguments.

From our literature review and interviews, we derived three significant arguments against the Equity Investment Model. First, the success of the Equity Investment Model cannot be properly measured. Second, the Equity Investment Model creates ethical conflicts. Lastly, the small amount of funding provided through the Equity Investment Model is too insignificant to provide benefit to the DoD.

A. ARGUMENTS AGAINST THE EQUITY INVESTMENT MODEL

The DoD faces significant challenges for measuring the results of Equity Investment Government VC initiatives. Despite In-Q-Tel's categorization as an Equity Investment VC initiative, the company's leadership has a different philosophy. In our interview with D. Tighe, the Vice President of In-Q-Tel, he pointed out that, while it is pleased to earn any financial returns to save taxpayer dollars, In-Q-Tel does not solely aim for financial gain. In fact, Tighe (2007) defined In-Q-Tel's job as "technology integration, discovery and development" and "to some degree…about integration." Readers need to understand this philosophy because it challenges the measure of success. How do you measure the effectiveness of In-Q-Tel's technology integration, discovery, development, or integration? Clearly, the hard part of an Equity Investment VC initiative is determining metrics for success (Maney, 2004).

This challenge applies to all Equity Investment Government VC initiatives, especially when the DoD does not yet have sufficient data on past performance. OnPoint is also struggling with this fact right now. OnPoint's goal is to deliver innovative products to the warfighter. Thus far, OnPoint's only successful technology transfer is a longer-lasting battery pack. With only one product transfer, has OnPoint been

successful? The Army Audit Agency Report estimated a cost savings over $375 million for the entire DoD because of the battery power indicator. This is a substantial savings and could certainly support the benefit of an Equity Investment VC initiative. Unfortunately, statistics are not so readily available that show cost savings for other Equity Investment activities. The Equity Investment Government VC initiatives should remain focused on identifying measures of success. These Government VC initiatives are promising, but the DoD needs to properly defend the execution of taxpayer dollars to support them.

Additionally, the DoD must realize the potential ethical conflicts created by the Equity Investment Model. In-Q-Tel's primary benefits lie in the venture team's relationships with prospective and promising companies, as well as the team's ability to support those companies' growth (Arlen, 2004). Unfortunately, there might be those who want to take advantage of the insider information gained from that position. In addition, the Equity Investment Government VC initiatives have to be aware of the perception given by this unique position. Already, In-Q-Tel contended with the negative publicity surrounding policies on executive compensation and employee profit-sharing, which created public controversy (Kaufman, 2006). The Equity Investment Model challenges the status quo for federal acquisition, so leaders and managers need to keep the initiatives above reproach in order to sustain the advantageous work performed in these organizations.

Lastly, proponents of the Equity Investment Model must contend with an argument that attacks the core of its use—does the relatively small amount of government "seed" money make a significant difference? We encountered this argument in an interview with J. Miller of ComVentures, who supports the DeVenCI effort. J. Miller pointed out that, in the current private equity and venture market, there is a tremendous amount of capital available for start-ups. Federal funding through the Equity Investment initiatives might not be as powerful as hoped because, "as a company starts to mature, there are many, many sources of capital that are looking to invest at early stages," and there has "been a return to the market of hedge funds and private investors looking to invest in private companies again" (Miller, 2007).

Why might the large amount of capital pose a problem for the government? First, the many alternatives for capital might make the process for qualification and the relatively small amount of money available (i.e., $500K - $1M) relatively unattractive. Second, venture investing is a zero-sum game—meaning that when a company lets the government organization invest, it is excluding someone else from owning a part of the company. Miller (2007) argued that "for hot start-ups, there tends to be investors in the company scrambling to own as much of the company as they can." In addition, a company might decide it is not in its best interest to give ownership to the government. We need to point out that this argument has not been fully researched. The next chapter compares the dollar amount invested by Equity Investment Government VC initiatives to firms in the VC industry to determine if the Government VC initiatives are investing enough money. However, the researchers did not investigate whether equity investments have played a major role in determining return on technology. We strongly recommend additional research into this area to determine whether an equity investment is even needed to have any return on technology.

B. ARGUMENTS AGAINST THE GRANT MODEL

Like the Equity Model, the Grant Model is opposed by its share of arguments which future research should address. This section does not contain an all-inclusive list of SBIR, the NTA RTVG, and ACIN shortcomings, but rather the four most significant points plaguing them:

1. "Customers" of the Grant Model deal with bureaucracy and the limits of finite resources, which cause delays.
2. Asymmetrical motivation—the entrepreneur must be proactive in getting the funds.
3. Grants do no increase social benefits.
4. Certain Grant Models, such as SBIR, have created a microcosm of "vulture" companies which rarely commercialize products, yet still receive grants.

We will now elaborate on each of these points and provide specifics.

1. Bureaucracy and Finite Resources Cause Delays

The stereotypical bureaucracy commonly associated with government or government-associated programs seems to be most rampant with the Grant Models. For example, the SBIR program works on a competitive proposal basis. The decision to grant funds to a particular company could very well only happen because laws mandate agencies to grant a certain percentage of their budgets toward SBIR. Thus, an undeserving project may get funding merely so a government office can meet its quota. The employees administering SBIR programs probably do not award funds as judiciously as a traditional VC, because their decisions have no bearing on their financial compensation. This lack of financial incentive seems to also cause delays in granting funds.

ACIN's incubation services promise the right companies free office space and business guidance. We have strong reason to believe such an attractive offering has high demand among entrepreneurial companies—and they are competing for space in ACIN's 20,000 square foot Waterfront Technology Center in Camden, NJ. This "no room at the inn" syndrome can cause delays in developing new technologies, simply because companies which would benefit from the incubator services will be shut out.

Finally, the insertion of the NTA as a coordinating link between the traditional VC community and the government adds another layer of fund management, which likely causes delays. The NTA must not only screen companies for promising technologies, but must scrutinize them for the government. Possibly the most significant factor causing delays for the DoD is that the DoD's interest might not necessarily be represented by the NTA's executor, the National Geospatial-Intelligence Agency.

2. The Entrepreneur Must Be Proactive to Receive Funding

The lure of "free money" has entrepreneurs competing and clamoring for finite resources: government-backed grants and incubator services. We might consider SBIR and the NTA as the "sellers," and the entrepreneurial firms as the "buyers"—but all

parties operate within a "sellers' market." Thus, firms must be proactive to receive grants, whether through a competitive proposal with SBIR, or by vying for consideration as "best-of-breed" entrepreneur by the NTA. They must be proactive because the administering offices for SBIR and the NTA do not have to seek out willing grantees since they all but line up at their doors. This highlights another shortcoming of the Grant Models: entrepreneurial firms are looking for free money, and do not necessarily value the marginal benefit their technological innovation will provide the government. Since Grant Model programs do not actively seek out candidates to receive their dollars, the outcomes are less controllable.

3. The Supposed Apolitical Nature of the Grant Model (SBIR)

SBIR was intended to be a political program, but politics still seem to have a negative effect on social benefits. The political pressure to maintain the impression of a successfully run government program may run counter to the best interest of technological advancement SBIR projects bring to society. Opponents of the Grant Model say it does not, in reality, increase social benefits, because political influences steer the dollars toward projects which will garner votes, but not necessarily grant necessary capabilities. Politicians like "success stories" for their campaigns, especially ones which allow them to brag about a grant which catalyzed a local company's success. However, these stories will carry less clout if a project is funded, but the firm never achieves commercialization. Cohen and Noll (1991) state that politicians can claim credit for the firm's ultimate success even if the marginal contribution of the public funds was very low (Lerner, 1999). Therefore, politicians may exert pressure on SBIR subunits to award grants to firms most likely to succeed, despite their projects' merit of social benefits. Finally, there is a question of the subunits and their agendas. Lerner (1999) says awards center on firms' ability to meet agency (subunit) needs, not their innovation. Thus, it seems the SBIR program does not have the built-in incentives necessary for interested parties to use it as intended.

4. The Existence of SBIR "Mills"

Finally, the SBIR program's many benefits make it a very attractive alternative to equity-based VC models; yet, at the same time, these benefits can create unintended, negative consequences. The most significant consequence is the creation of "parasitic" small businesses, which receive a disproportionate number of SBIR grants (Lerner, 1999). To understand why this is a negative consequence, one must understand the rationale for the SBIR program: the grants are designed to spur innovation for projects which would not otherwise obtain funding. The grants are *not* meant to be "handouts" for well-connected small businesses which merely want to avoid giving away equity in their company.

The promise of grant money captures wide attention in entrepreneurial circles, including that of "freeloading" companies, which have no intention of maturing their organization to the point of no longer needing grants. This phenomenon is referred to as the "SBIR mill" (Lerner, 1999, p. 296). Although the SBIR program's funding authority has always had an expiration date, Congress has never let the program lapse since its inception in 1982. Thus, the small businesses continually receiving awards (which are neither commercializing nor growing) have developed a certain dependency on grants—clearly a growing concern. Experts concluded it takes five to nine years for a company to progress from a concept to a commercial product (Lerner, 1992). According to a 1992 GAO report, these companies continually receiving grants would have made the leap to being large businesses, or at least would have commercialized more products without the promise of SBIR grants. Indeed, many of these "freeloaders" have staffs in Washington that focus on identifying opportunities for applications; yet, they appear to commercialize projects at a significantly lower rate than other firms (Lerner, 1992). Such dependency on the "SBIR mill" is one of the most profound arguments against the Grant Model.

The next section will determine differences, as well as the advantages and disadvantages, of the various Government VC initiatives, compare and contrast the investment portfolios of the VC industry vs. the Government VC initiatives, and determine if the VC industry provides a relevant source for government R&D.

C. THE *REAL* PROBLEM IS TRANSFERRING THE TECHNOLOGY

All the Government VC initiatives have succeeded in partnering with the commercial industry to increase the DoD's social network. The DoD has a tool in the Government VC initiatives to tap into the emerging innovative technology out in commercial industry. However, is the DoD only looking for exposure? If so, is that the sole measurement of success? Again, we would like to emphasize that a meaningful metric for the success of the different Government VC initiatives is nebulous, at best. All the Government VC initiatives are successful in one way or another, but there are arguments against some Government VC initiatives. Are the Government VC initiatives really successful at transferring technology into the DoD infrastructure? We found information to support this argument from different sources. The first sources discussed are audits conducted by BENS (2001) and an audit conducted by the Senate's Select Committee on Intelligence (SCI) (2007).

BENS (2001) stated that In-Q-Tel is successfully delivering innovation to the CIA, but faces challenges when transferring the technology into the CIA's infrastructure. In-Q-Tel's business model is a challenge to the CIA's security framework, which requires time to insert the new technology. Any technology inserted into the CIA must be reviewed by up to six formal boards (BENS, 2001). The audit conducted by the SCI (2007) found similar challenges similar to BENS' findings (2001). SCI (2007) found that In-Q-Tel's successes are mostly in the area of analytic tools, but the CIA's old infrastructure and bureaucratic processes hinder the transference of the new technology. The NRAC (2006) and the Army Science Board (ASB) (2001) found the same challenge during their VC panel.

The ASB (2001) was tasked to conduct a study on VC as a tool for the Army; it suggested the Army should not create a VC firm such as In-Q-Tel. The overall finding by the VC panel was, "The critical issue is not the generation of funding for science and technology, but the Army's ability to identify transformational, commercial technologies and policies and procedures to transition those technologies rapidly into Army system" (2001, slide 17). The Army still decided to create OnPoint after the findings by the ASB

VC panel. The NRAC (2006) VC report pointed out prior recommendations for acquisition reform and technology insertion that were never implemented. The NRAC VC panel also cautioned against creating a VC firm such as In-Q-Tel for the Navy. What specifically did these studies find that makes technology transition so difficult?

The National Research Council (NRC) of the National Academies published a paper in 2004 titled, "Accelerating Technology Transition: Bridging the Valley of Death for Materials and Processes in Defense Systems." In this paper, the NRC (2004) discussed the importance of and the difficulties in transitioning technology. Some of the main challenges discussed in this paper are the impediments stemming from the DoD's "cultural traits." The NRC says the DoD's culture tends to be very bureaucratic, and its acquisition processes usually favor large businesses over smaller, start-up companies. The NRC (2004) found that based on historical data, the DoD has been inefficient at inserting new technologies into defense systems.

Most—if not all—of the Government VC initiatives have some sort of team responsible for transferring technology, but are they efficient and effective? Based on the various sources from government and independent audits to agency VC panels, it seems that new technology is being introduced, but faces challenges with the transition. This argument is probably the most important one, and will be further discussed in our conclusion. However, before our conclusion we will analyze the information and data gathered from the VC industry, Government VC initiatives, and the *QDR*. More specifically, we will refer back to and answer the research questions raised in Chapter I.

VI. ANALYSIS

In the previous chapters, we have discussed data and information on the VC industry, current investment activities of the DoD Government VC initiatives, and the characteristics of the DoD Government VC initiatives in the context of the DoD VC spectrum. We have also recommended *QDR* investment areas and presented arguments against the VC models. With this information, we will: 1) analyze the advantages and disadvantages of the models, 2) conduct a comparison and contrast of the VC industry and DoD VC investment portfolios, and 3) formulate a determination of the VC industry as a relevant source for DoD R&D.

A. ADVANTAGES AND DISADVANTAGES OF THE DOD VC MODELS

We characterized the Government VC initiatives along a spectrum in order to better understand their distinguishing characteristics. An understanding of the characteristics of the Equity Investment, Grant, and Communication Catalyst Models will help leadership make decisions about future Government VC initiatives. To further facilitate decision-making, this sub-section provides a discussion of the advantages and disadvantages for each model. Figure 22 provides a summary of the advantages and disadvantages of the VC models. This matrix will help decision-makers quickly identify models that present the best opportunities.

ADVANTAGES	Social Network	Overcome Bureaucracy	Certification Effect	Leverage funding	Increased insight	Enhance technology base	Fill funding gap	Minimize cost
Equity Investment Model	X	X	X	X	X		X	X
Grant Model	X	X	X			X	X	
Communication Catalyst Model	X	X						X
DISADVANTAGES	Potential ethical conflicts	Change management challenges	Human resource intensive	Technology Transition challenges	Difficulty measuring success	Unintended Consequences: Crowding out effect	Unintended Consequences: Manipulation of the system	
Equity Investment Model	X	X	X	X	X			
Grant Model				X	X	X	X	
Communication Catalyst Model				X	X			

Figure 23. Summary of Advantages and Disadvantages of Government VC Models

1. Equity Investment Model

The Equity Investment Model provides six distinct advantages: increases the government's VC social network, helps the acquisition community overcome bureaucracy, provides a certification effect to other investors, enables the acquisition community to leverage additional funding, provides the DoD with increased insight into firms and products, and minimizes overall R&D costs.

The primary motivation for the VC movement in government centers around the concern that we do not have access to the information about products and services that can improve our warfighting capability. The Equity Investment Model enables the DoD to directly participate in the VC community, thereby enhancing the DoD's social network. A social network is a structure that consists of nodes (usually people or organizations) that are linked together by common values or ideas. For instance, In-Q-Tel's ability to network with its matrix of venture teams to provide marketing insights and strategic guidance benefits the DoD, the VCs, and the start-up companies (Lerner et al., 2004). In fact, this network proved invaluable for In-Q-Tel because "the most common source of introductions that led to In-Q-Tel investments […] was through network members, either through a company's network, In-Q-Tel's network, or a combination of the two" (Belko, 2001, p. 69).

The unique relationship derived from equity investment also helps the acquisition community overcome bureaucracy. The literature indicates that the amount of paperwork and legal obstacles hinder small, innovative companies from doing business with government. The funding process of the government is incredibly bureaucratic, and companies who have never done business with the government quickly learn that Congressional appropriations equate to a relatively significant cost in time—time that is precious for a start-up company (Lerner et al., 2004). While stakeholders understand the need for this bureaucracy, leadership must understand the trade-off. The entrepreneurs should spend time developing innovative technologies to increase the DoD's warfighting capability—not filling out paperwork. When given the choice, many small companies

will choose to do their business elsewhere. For this reason, the Equity Investment Model enables the government to do business with the start-up companies in a more collaborative fashion (Arlen, 2004).

This trade-off, while minimizing oversight, actually increases the DoD's insight into the start-up companies. The Equity Investment Model enables the government to gain seats on the management boards, resulting into an insider's view of the company and its product. This insight allows the government to identify problems in product development (Arlen, 2004). In traditional acquisition structures, the company is not necessarily required to tell the government all its problems. However, under the Equity Investment Model, the VC initiative can identify problems earlier.

Because the DoD can leverage additional funding with VC, the government achieves this position of influence at the same time as it enjoys a potentially lower R&D cost. The VC funding process brings the government together with private VC firms and innovative companies to establish a partnership that invests more funding than the DoD provides. As discussed by Lerner et al. (2004), the Equity Investment Model enabled the CIA to sample the technology before it bought it, all while leveraging other funding. In-Q-Tel recognized that $40 million was a relatively insignificant amount of money for a direct procurement (Lerner et al., 2004). Equity investments allow the government to share the cost for R&D. OnPoint's success is evidence of this fact—"for every dollar invested by OnPoint, private venture capital investors have co-invested more than six dollars" (Rottenberg, 2006, p. 46).

Admittedly, the leverage argument has to be the primary advantage of this model because the government has to leverage its funds—it cannot provide comparable funding to compete with VC investors. Obviously, this is not the goal of a Government VC initiative. However, the Acknowledgements section contained the argument that Equity Investment suffers from this small amount of money because there are decreasing opportunities in the market (J. Miller, 2007). However, in an interview with Gilman Louie, former CEO of In-Q-Tel, In-Q-Tel's association with the CIA (and the associated "test bed" environment) far outweighed In-Q-Tel's small amount of money (Louie, 2007). In fact, Mr. Louie stated that In-Q-Tel's structure as a strategic venture fund

required that In-Q-Tel market its technical due diligence and position as a "seal of approval." (Louie, 2007). The equity investment enables the government to gain improved insight, but, by providing unique, value-added input to small companies, the government's knowledge and input far outweighed the relatively small amount of equity.

Mr. Louie mentioned In-Q-Tel's position as a "seal of approval." (Louie, 2007). In addition to leveraging funds, the Equity Investment Model results in a phenomenon known as the Certification Effect. Both Lerner and Wallsten discuss this phenomenon and how it relates to public venture programs; however, evidence indicates that there is a Certification Effect with the Equity Investment Model as well. The Certification Effect describes the unofficial signaling sent to other companies and investors about the potential for technical excellence by a small company when the government shows interest in the company's product. For In-Q-Tel, the government "certifies" companies simply by showing interest, as well as by providing an early testing environment with their technology laboratory (Lerner et al., 2004). In a study conducted by Belko (2001) at the Air Force Institute of Technology, the Certification Effect (or technological validation) ranked as the second most important reason companies were attracted to In-Q-Tel. In fact, 9 of the 13 companies believed their company's relationship with In-Q-Tel provided a level of credibility with other companies and investors (Belko, 2001).

Despite the advantages of the Equity Investment Model, leadership must be aware of several disadvantages. We discussed in the Acknowledgements chapter that this model potentially creates an environment for ethical dilemmas. Leadership must spend time considering and developing policies and procedures for an Equity Investment initiative that will not give an appearance of impropriety.

Leadership must also give due consideration to the cultural resistance to Equity Investment activities. Change management must be a priority because the DoD can be a risk-averse culture, and its members many times feel a need for a high level of control. Arlen (2004) points out that we must commit to an Equity Investment initiative and have a willingness to work with people who are very different than those with whom we normally work in the government. Not only must we be comfortable working with different people, but we also need to get comfortable with a different process. VC is very

different than the traditional acquisition structure, so DoD employees should not expect the working relationship to be similar to that created when managing defense contractors. The VC approach is collaborative and requires flexibility.

The need for culture change requires personnel with a new set of skill sets to lead Government VC initiatives. The human resource aspect of an Equity Investment initiative can be intense because the DoD must recruit, staff, and pay personnel with different skills sets. The type of personnel we are looking for are very competitive in the commercial market. The Acknowledgements chapter discussed the potential ethical dilemmas created by compensation packages at In-Q-Tel. Despite this challenge, Mr. Louie stressed the need (and overall success) of the compensation agreements because the arrangement incentivized technology transition. On the surface, the ability of employee's to earn 10-40% based on company performance might be ethically questionable. However, Mr. Louie established metrics that asked how many technologies were actually adopted by the CIA and how many technologies were actually piloted? These metrics were used to then reward the employees. Therefore, the employees were not simply profiting from investments with taxpayer dollars because the overall goal was to deliver useful products to the warfighter. Unfortunately, In-Q-Tel no longer has an equity sharing program for its employees. (Louie, 2007)

In-Q-Tel achieved success with incentivizing technology transition. As Mr. Louie stated, only 10% of the companies In-Q-Tel invested in ended up failing, which is a phenomenal rate for VC investing (Louie, 2007). Despite In-Q-Tel's success, technology transition still presents a significant challenge to the Equity Investment Model as well. In many of the interviews for this project, respondents mentioned the difficulty of transitioning the technology to the warfighter. The DoD possesses many tools to facilitate this process, such as Advanced Concept Technology Demonstrations (ACTDs). However, the DoD has not officially established a process or procedure for linking the Government VC initiatives with any of these Technology Transition organizations. Leadership must consider this phase of the VC acquisition process.

Lastly, as discussed in the Acknowledgements section, a significant challenge to the Equity Investment Model is determining how to measure success, In-Q-Tel still

struggles with this issue. It had to update its metrics to focus on technology insertion instead of number of proposals received (Molzahn, 2003). OnPoint also recognized the challenge of technology transition to the Equity Investment Model. OnPoint's focus is on "a company that has a strong chance of transitioning technology" (Cox & McGee, 2005, p. 64), so it can measure how many products are transitioned to the warfighter. In this period of decreasing budgets, leadership must adequately communicate how to define success so managers will be able to strive for, measure and communicate success.

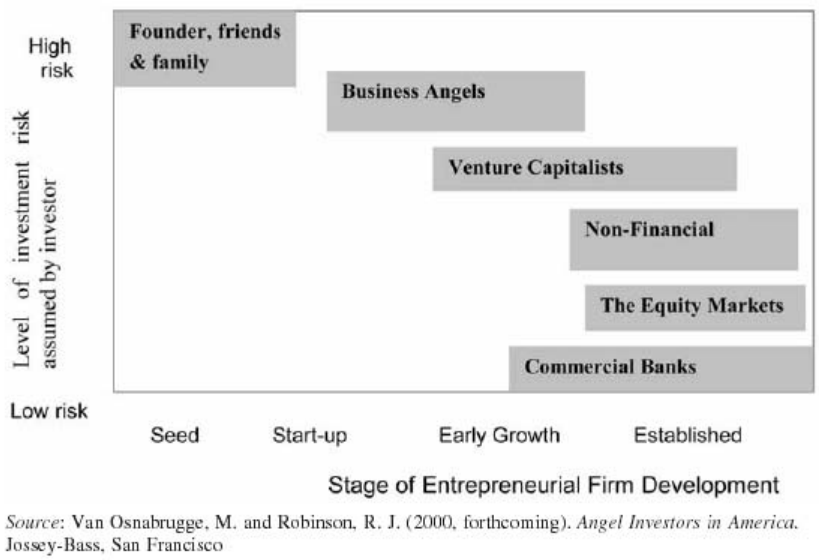
2. Grant Model

The Grant Model provides numerous advantages as well. As with the Equity Investment Model, the DoD can expand its social network with the Grant Model. While the SBIR program can be bureaucratic, ACIN and the NTA have developed procedures for overcoming the bureaucracy. The Army allowed industry partners to retain data rights for commercial purposes, but also structured a payback method for royalties to be returned to ACIN for maintenance and operations (Deitch, 2004).

While social networking and overcoming bureaucracy are benefits of the Grant Model, the model's true power lies in three specific areas: the Certification Effect, filling a funding gap in the VC industry, and enhancing the technology base. As discussed earlier, the Certification Effect signals other investors that a company possesses technical potential. Lerner argues that this is a primary benefit of public VC programs because "public subsidies for small high-technology firms […] convey information to other potential investors" (Lerner, 1999, p. 291). The government cannot underestimate the importance of the Certification Effect.

By providing valuable information to potential investors, Government VC initiatives are able to fill a gap between small companies and investors. This gap exists because private capital markets are unable to collect sufficient information on the projects of small companies (Lerner, 1999; Cooper, 2003). The gap exists not only because of the inability to gather such information but also because VC firms choose not to spend time and money on investigating smaller ventures (Cooper, 2003). Thus, the government performs a critical function with Grant Model initiatives. One such gap exists between

seed and start-up stages in VC funding, which can be seen in Figure 23 below. If the DoD contemplates the use of a Grant Model initiative, leadership should take this information and funding gap into account.



Source: Van Osnabrugge, M. and Robinson, R. J. (2000, forthcoming). *Angel Investors in America*. Jossey-Bass, San Francisco

Figure 24. Funding Gap [From Cooper, 2003]

The final advantage of the Grant Model lay in the DoD's ability to enhance its technology base. Congress established the SBIR program in order to enhance U.S. competitiveness. Evidence indicates that companies supported by the SBIR program grew at a faster rate than similar firms. In fact, in survey responses, companies indicated that 50% of the firms surveyed would not have started or continued if the SBIR program had not been available (Cooper, 2003). Clearly, the Grant Model represents an opportunity for the DoD to commercialize technology while enhancing the technology base.

Unfortunately, the Grant Model's success is hindered by critical disadvantages. First, DoD leaders and managers are significantly challenged by the need for change management. The government culture can be risk-averse and controlling. The SBIR program provides the best solution for these challenges. Within the government's risk-averse culture, evidence indicates that managers are unwilling to fund marginal efforts because regulatory guidelines do not encourage them to fund such projects. What is the

result? There is a "remarkably high success rate of funded projects [that…] did not take sufficient risks" (Wallsten, 2000, p. 86). Adding further frustration is the fact that evidence indicates that actual investment is relatively low—a paltry 3% of SBIR projects have received VC investment—despite the high success rate of funded projects and the potential for VC investment during Phase III (Cooper, 2003).

Lastly, the unintended consequences of Grant Model initiatives provide reasons for concern. With the SBIR program, evidence indicates a crowding-out effect of industry R&D and a manipulation of the proposal system. Wallsten's study argued that the government should see an overall increase in industry's R&D activities when a company earns grant funding because the company should initiate R&D activities that were not previously considered profitable. Unfortunately, evidence suggests otherwise. Wallsten found that the amount of grant funding does not affect employment, which seems to indicate that companies are simply supplementing their own R&D funds with government subsidies (Wallsten, 2000).

The same study by Wallsten indicates that certain entities have developed a specialty for winning SBIR contracts and may be manipulating the system. These companies have come to be known as "SBIR mills." This phenomenon may be further complicated because government managers factor past performance into award decisions and do not necessarily take into account the potential for technological innovation from unproven offerors (Lerner, 2003).

3. Communication Catalyst Model

The Communication Catalyst Model provides an interesting opportunity for the DoD. This model attempts to capture many of the benefits of the other models without the capital investment. The Communication Catalyst Model's primary advantage is its seemingly minimal cost compared to the other models. The government does not participate in equity investment and can dedicate a smaller number of personnel to the initiative. For instance, the Communication Catalyst Model significantly increases the DoD's social network. DeVenCI's team of eleven venture capitalists is unpaid, yet they provide access to knowledge and contacts that would be virtually inaccessible for the

government (DeVenCI, 2007). We will have a difficult time placing a value on the social networking benefits of these models. And though the DoD gives up the opportunity to directly influence the companies, with the Communication Catalyst Model, it is gaining access to the network for a lesser cost.

Despite the smaller investment, the Communication Catalyst Model still enables the DoD to minimize the timeline for identifying emerging technologies. The establishment of DeVenCI focused on the need to increase DoD awareness of emerging commercial technologies developed by non-traditional DoD procurement sources to help fight the Global War on Terrorism (Pohanka, 2007). DeVenCI's primary objective is to identify commercially developed products that are mature enough for warfighter use with minimal modification.

The quick identification of technology will hopefully enable delivery of a capability to the warfighter in 6-18 months (Pohanka, 2007). Admittedly, the responsibility for technology transition lies with the traditional acquisition organizations. There are still significant challenges for this model in that arena. However, the overall minimal cost compared to the other models with many of the same advantages makes the Communication Catalyst Model an attractive option for leaders considering a VC initiative.

Leaders should not discount the challenge of transitioning technologies brought to the DoD by DeVenCI. Mr. Jeb Miller, one of the DeVenCI VC consultants, recognizes this challenge. He is adamant that the DeVenCI team will significantly decrease the timeline for technology identification. However, he questions "how we can best shorten the timeframe to actually procure technology, that's a piece we don't yet have the good case studies for" (Miller, 2007). Mr. Gilman Louie supports this assertion. He stated that finding technologies and providing funding are the easiest parts of VC to accomplish-technology transition and adoption is the most difficult aspect o Government VC (Louie, 2007).

For most of the VC models, we lack past performance data, which makes it difficult to measure and determine success. This is especially true for the

Communication Catalyst Model. Observers will have to be patient to see how initiatives such as DeVenCI and the CTTO successfully build relationships and bring together VCs, innovative companies, and the warfighter. Ultimately, the researchers of this article firmly believer that technology transition and adoption are the critical goal; therefore, metrics must center on this goal to determine success.

B. VC INDUSTRY AND GOVERNMENT VC INITIATIVE PORTFOLIOS

In Chapters II and III, we assessed the VC industry and Government VC initiatives separately. We discussed the VC industry and Government VC initiatives' resources, investments, portfolio companies, exits, and performance. This section integrates information about the VC industry and Government VC initiatives based on previous independent assessments. More specifically, we answer the following questions by comparing and contrasting the VC industry to Government VC initiatives:

1. Are the government's equity investments and total capital under management significant compared to the VC industry?

2. What investment stage is the government equity investments mainly concentrated and is this effective with the current VC industry conditions?

3. What is the average age of investments made by Government VC initiatives compared to those made by the VC industry?

4. How do exits made by Government VC initiatives compare to exits from the VC industry?

5. Is there a trend in the geographic concentration of investments made by Government VC initiatives and the VC industry?

The answers to these questions can provide the basis for implementing a government VC initiative. By understanding the VC industry, the government can make the best determinations about how to structure, focus, and execute Government VC initiatives.

1. Are the Government's Equity Investments and Capital under Management Significant Compared to the VC Industry?

This question only pertains to Government VC initiatives with equity investments. We addressed this question earlier in our Acknowledgement chapter as an argument against the Equity Model. However, based on a comparison of the resource and investment data for government equity models and the VC industry, we believe the equity investments made by Government VC initiatives and capital under management are significant compared to private firms in the VC industry.

According to the *NVCA Yearbook* (2007a), 43% of all VC firms managed up to $50 million, while 21% managed at least $250 million in 2006. On average, OnPoint managed up to $12.36 million per year since its inception in 2003, while In-Q-Tel managed up to $40 million per year since its 1999 inception. In-Q-Tel's capital under management is similar to about half of all the private firms in the VC industry with investments up to $50 million. OnPoint is similar to the bottom 15% of all private VC firms; however, OnPoint is in the upper economic portion of the 15%, with $12.36 million under management. G. Burnette, who was one of the general partners at Red Planet Capital, said it is reasonable to have a $30 or $50 million fund outside Silicon Valley. Burnette (2007) said smaller funds are reasonable "in part because there is not as much company generation going on outside of Silicon Valley so you can invest smaller amounts at a slower pace" (2007). We believe that OnPoint and In-Q-Tel's capital under management is significant for equity investments, since almost half of the private VC firms only manage up to $50 million.

Private VC firms (on average) invested $5.26 million for initial-round financing and $10.25 million in follow-on financing. In-Q-Tel makes $500,000 to $3 million investments, while OnPoint's investments are $500,000 to $2.5 million. On average, each private VC firm invested in four companies in 2006, while In-Q-Tel averaged almost 13 per year and OnPoint four to six per year. Unlike private VC firms, In-Q-Tel and OnPoint make strategic investments instead of financial investments, so they do not need to match the investments made by private VC firms.

In-Q-Tel is more than capable of matching the private VC firms based off its capital under management. Likewise, OnPoint's capital under management allows it to match the private VC firms' initial-round financing. However, due to the strategic investments, In-Q-Tel and OnPoint are not looking for a return on investment, so they do not need to make big investments. According to Louie (2007), In-Q-Tel's objective was focused on sub-optimizing across its portfolio by investing the least amount of money possible to gain access to the most amount of technology in its earliest stage. This is probably why In-Q-Tel and OnPoint make more investments on average per year than private VC firms.

2. What Investment Stage(s) are the Government Equity Investments Mainly Concentrated and are these Effective with the Current VC Industry Conditions?

Government equity investments are primarily concentrated in early-round financing. Despite the small amount of capital managed, government equity investments are significant. They are not meant to compete with private VC firms that manage greater than $250 million. The amount of capital a Government VC manages seems to determine when it invests. This finding is supported by interviews with VC fund managers, articles, and other research.

Government equity investments are mostly made in Series A and B rounds, or the initial-round financing. Tighe (2007) said that even though In-Q-Tel does not concentrate in one area, it has a history of primarily investing in Series A and B rounds. Burnette (2007) said, "it is very rare that a company can use $10 million as its Series A round." Burnette (2007) stated that Red Planet Capital planned to initially invest small amounts in early-stage companies and increase the funding every year as the companies hit their milestones. He also pointed out that investing small amounts does not work for big funds such as Sequoia because "they just have too much money that has to be parked somewhere" (2007). This leads into how small and big VC firms interact and how this interaction supports small government equity investments.

According to Nooteboom (2002), small VC firms have relatively lower transaction costs because they handle early-stage investments more efficiently than larger firms. A firm managing $500 million cannot make many $2 million deals because the transaction costs alone exceed the benefits. Due to these transaction costs, larger VC firms depend on smaller ones to deliver information on new, promising companies (Hibbard, 2004). Hibbard (2004) believes small VC firms have the edge now because the early-stage companies are worth less than they were in the late 1990's. This makes early-stage investments smaller and larger VC firms' investments harder (Hibbard, 2004).

Manigart et al. (2002), in a five-country study, found that VC firms had lower required return on investment for all stages, with a greater percentage of smaller investments. Investments in startup and seed-stage companies increased 44.2% from 2005. This high percentage is explained by the industry concluding existing projects and focusing instead on the new, upcoming deals (NVCA, 2007). According to Nooteboom (2002) Hibbard (2004), and Manigart et al (2002), the government can make small equity investments in Series A and B early-stage rounds and take advantage of the current VC industry trend.

3. What is the Average Age of Investments Made by Government VC Initiatives Compared to those Made by the VC Industry?

In-Q-Tel is the only government VC initiative with historical data to make this comparison to the VC industry. OnPoint is still young compared to In-Q-Tel, with an average age of 3.5 years (at most) for its investments. All other Government VC initiatives do not pertain to this question, because they do not make equity investments. In-Q-Tel has 60 companies in its portfolio, with investments in 50 of the companies. The average time since In-Q-Tel's first investment in each of those 50 companies is 36 months (In-Q-Tel, 2007). How does the average age of In-Q-Tel's investments compare with the VC industry?

The median age of all venture-backed IPOs increased to 96 months in 2006 from 72 months the previous year (NVCA, 2007). In-Q-Tel's investments are still fairly young compared to the venture-backed IPOs. If In-Q-Tel is concerned about IPOs, then

its investments still have around 60 months before the possibility of going public. However, In-Q-Tel is not worried about IPOs because it focuses on return on technology in contrast to financial returns from IPOs. Even though an IPO is not a measurement of success for In-Q-Tel, it still has the potential to make a return on investment from IPOs.

In-Q-Tel's investment in Ionatron is an example in which In-Q-Tel profited from an IPO in one of its investments. According to the *NVCA Yearbook* (2007a), only 1 in 6 companies ever goes public. In-Q-Tel's 50 investments could result in about 8 IPOs within the next 60 months. Even though In-Q-Tel is not concerned about return on investment, the possibility of a new R&D funding mechanism from In-Q-Tel's return on investment cannot be ignored.

4. How do Exits Made by Government VC Initiatives Compare to Exits from the VC Industry?

In-Q-Tel is the only government VC initiative with data to answer this question. Since inception, In-Q-Tel had two IPOs with Ionatron and Electro Energy; however, six of In-Q-Tel's companies were acquired by companies such as Google and IBM (In-Q-Tel, 2007). This seems to correlate with the trend in the VC industry. According to the *NVCA Yearbook* (2007a), the most feasible route to exit for venture-backed companies is through a merger and acquisition (M&A). Venture-backed M&A activity accounted for 85% of the total exits in 2006. The VC industry only had 57 venture-backed IPOs in 2006 out of 798 private VC firms. In-Q-Tel's exits seem to follow the VC industry trend, with acquisitions accounting for the majority of their exits.

5. Is There a Trend in the Geographic Concentration of Investments Made by Government VC Initiatives and the VC Industry?

The researchers believe there is a trend in the concentration of investments. The figure below shows the top five states that received funding from the VC industry—In-Q-Tel, OnPoint, and SBIR. We retrieved this data from the *NVCA Yearbook* (2007a) and the organizations' website.

	VC Industry	In-Q-Tel	OnPoint	SBIR
1	CA	CA	CA	CA
2	MA	VA	MA	MA
3	TX	MA	MO	VA
4	NY	CO	VA	OH
5	WA	OR & MN	UK	CO

Figure 25. Top 5 States with the Most Funding

The VC industry and the Government VC initiatives all invested in California and Massachusetts. The Government VC initiatives all had Virginia in their top five. The Government VC initiatives seem to leverage their invested dollars with the VC industry well. SBIR does not make equity investments, but SBIR companies require additional funding during Phase III from private sources such as the VC industry. This means some companies that receive SBIR grants also receive funding from the VC industry. The Government VC initiatives can leverage their investment dollars with the VC industry by concentrating in few states; however, this can disguise the government VC initiative's true performance. We raised this concern in our argument against the Grant Model: the government has a tendency to only invest in what is popular and already successful.

The Government VC initiatives under the Equity Model seem to follow VC industry trends. Government equity investments and capital under management are significant enough for the VC industry. The smaller government equity investments can impact the rise in early-stage companies. Even though return on investment is not a goal for government equity investments, this could possibly provide an innovative R&D funding mechanism. However, this will be hard to implement in a risk-averse culture such as the DoD. The VC industry is a great source to tap into for the DoD. The next section analyzes how the VC industry can be a relevant source for government R&D.

C. VC AS A RELEVANT SOURCE FOR GOVERNMENT R&D

As the commercial world advances technology at an ever-increasing pace, can the government rely on the VC industry to "conduct" a major portion of its R&D and implementation, with dual-use technologies as deliverables? The short answer to this question is "yes," when the following analyses are conducted: 1) using the *QDR* focus

areas of investment, determine the amounts invested in each of those areas; 2) in considering the amounts invested in the *QDR* focus areas, determine whether a government-sponsored VC initiative would benefit from investing in those areas; and 3) determine VC funding options available in the *QDR*-defined areas.

1. Levels of Investment in *QDR*-focused Areas

The government's acquisition requirements reside in *five* main areas: information technology, medical & biotechnology, intelligence/surveillance, language/cultural learning, and logistics. Unfortunately, the different categories (areas of investment) in the *QDR* are not analogous to the main categories of VC investment as defined by the NVCA. The NVCA uses nine mutually exclusive categories to separate all VC into "industries." The misalignment of these categories can be seen in Figure 25 below.

QDR areas of investment:	NVCA investment categories:
Information Technology	Telecommunications
Medical & Biotechnology	Computer Hardware and Services
Intelligence & Surveillance	Computer Software
Language & Cultural	Business/Financial
Logistics	Semiconductors and Electronics
	Biotechnology
	Healthcare related
	Retailing and Media
	Industrial/Energy

Figure 26. Five QDR Areas of Investment vs. Nine NVCA Investment Categories

In order to properly determine if the VC industry can support government R&D, our research must align these categories. Why is it so important to "force-fit" each of these *QDR* investment areas into the NVCA categories? The actual data presented in the *NVCA Yearbook* is presented at the level of these nine investment categories; further granularity is not readily available and is beyond the scope of our project.

Using the Venture Economics Industry Codes (VEIC), the five areas of the *QDR* were matched to corresponding NVCA investment categories. These codes are VC's counterparts to the North American Industry Classification System (NAICS) and Standard Industrial Classification (SIC). A four-digit number gives the greatest level of

detail in identifying an industry. For example, the code 4525 is "biotech laser and optotronic applications." Matching "information technology" and "medical & biotechnology" to the NVCA investment categories was straightforward and obvious. This is the match-up:

QDR area of investment	NVCA investment category
information technology	Telecommunications
information technology	computer hardware and services
information technology	computer software
medical & biotechnology	biotechnology
medical & biotechnology	healthcare related

Figure 27. IT & Medical and Matched NVCA Areas

The more stubborn challenge came with matching "intelligence & surveillance," "language & cultural," and "logistics" to the broad VC investment categories. Which VEICs correspond to intelligence & surveillance, language & cultural, and logistics? This was largely a manual, qualitative decision made using the VEIC list found in the 2007 *NVCA Yearbook*. Thus, we looked through each VEIC in the list for codes relevant for the three unclassified *QDR* areas of investment. This is the outcome:

QDR area of investment	VEIC #	VEIC description	NVCA investment category
language & cultural	2733	educational Software	computer software
language & cultural	2752	natural language	computer software
language & cultural	7130	toys/electronic games	retailing and media
language & cultural	7550	education and educational products and materials	retailing and media
logistics	1560	e-commerce technology	computer hardware and services
logistics	2739	Enterprise Resource Planning (ERP) software	computer software
logistics	2873	data warehousing services	computer hardware and services
logistics	8230	process control equipment and systems	industrial/energy
logistics	9300	business services	business/financial
logistics	9340	distributors, importers, and wholesalers	business/financial
intelligence & surveillance	2910	voice synthesis	computer software
intelligence & surveillance	2911	voice recognition	computer software
intelligence & surveillance	3120	microprocessors, controllers, and sensors	semiconductors and electronics
intelligence & surveillance	3810	military electronics (excluding communications)	semiconductors and electronics
intelligence & surveillance	3835	Security/Alarm Sensors/Detectors	semiconductors and electronics
intelligence & surveillance	3900	Optoelectronics	semiconductors and electronics

Figure 28. VEICs for Language & Cultural, Logistics, and Intelligence & Surveillance

As the chart above indicates, the three unclassified areas of *QDR* investment do not fit neatly into the NVCA investment categories. For example, "logistics" fits into four of the NVCA categories: computer hardware and services, business/financial, industrial/energy, and computer software. In addition, we see many crossovers within each *QDR* investment area.

The common anchor among all five *QDR* investment areas is computers, more specifically software. Not surprisingly, the investment category with the greatest amount of investment in 2006 was computer software. Computer software has consistently been the top-funded sector for the last five years, and has been in the top three for the last 10 years. However, biotechnology has also emerged as a prominent VC category, particularly since the stock market's recovery from the dot-com bear market beginning in 2002. Its move from the bottom half of the sectors to the top, after 2002, indicate its growing importance.

	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	Total
Computer Software	3,417	4,529	10,511	24,377	10,342	5,231	4,469	5,253	4,809	5,023	77,961
Biotechnology	1,438	1,595	2,098	4,311	3,412	3,161	3,693	4,273	3,863	4,656	32,500
Telecommunications	2,578	4,368	12,649	28,438	11,213	5,107	3,559	3,534	3,964	3,675	79,085
Healthcare-related	1,887	2,113	3,021	3,898	2,529	2,224	1,823	2,092	2,604	3,067	25,258
Semiconductors and Electronics	884	872	1,637	4,372	2,760	1,842	2,026	2,576	2,268	2,732	21,969
Retailing and Media	2,036	3,135	12,303	17,286	3,533	1,140	1,124	1,463	1,675	2,375	46,070
Industrial/Energy	783	1,486	1,873	2,725	1,280	744	828	761	912	1,866	13,258
Computer Hardware and Services	1,051	1,457	5,041	10,330	3,047	1,510	1,121	1,206	1,413	1,443	27,619
Business/Financial	819	1,534	5,073	9,246	2,580	870	1,041	980	1,270	1,085	24,498
Total	14,893	21,089	54,206	104,983	40,696	21,829	19,684	22,138	22,778	25,922	348,218

Figure 29. Dollars Invested by Industry Sector, in Millions
[From NVCA, 2007]

	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	Average 10 -year rank
Computer Software	1	1	3	2	2	1	1	1	1	1	1.4
Biotechnology	5	5	7	7	4	3	2	2	3	2	4
Telecommunications	2	2	1	1	1	2	3	3	2	3	2
Healthcare-related	4	4	6	8	8	4	5	5	4	4	5.2
Semiconductors and Electronics	7	9	9	6	6	5	4	4	5	5	6
Retailing and Media	3	3	2	3	3	7	6	6	6	6	4.5
Industrial/Energy	9	7	8	9	9	9	9	9	9	7	8.5
Computer Hardware and Services	6	8	5	4	5	6	7	7	7	8	6.3
Business/Financial	8	6	4	5	7	8	8	8	8	9	7.1

Figure 30. Relative Ranking of Sectors by Dollars Invested
[From NVCA, 2007]

2. Feasibility of Government VC Initiatives to Pursue QDR Investment Areas

The government would benefit using VC to fill its capability gaps within *all QDR* investment areas. However, this does not necessarily mean it should invest actual taxpayer dollars in each investment area. VC is a relevant source for government R&D for the following reasons:

- The ever-increasing employment of dual-use technologies within the DoD can take advantage of entrepreneurial breakthroughs resulting from successful ventures. These breakthroughs typically result in COTS items, which require little, if any, modification to make them suitable for DoD use. We see no reason the government should not be a stakeholder in new technologies with its VC initiatives to steer dual-use technology developments.

- Traditional government acquisition practices typically trail the private sector by 10 years or more (R. Rendon, personal communication, September 12, 2007). The government is doing itself a great disservice isolating its R&D efforts. The processes tend to be slower, do not leverage funds, and do not interface with the commercial market to the same degree as VCs.

- The *QDR* investment areas are each highly reliant on Internet-based technologies. As the charts in the previous section demonstrated, the trend in VC is an increase in software development, which, in turn, depends largely on Internet technologies. (NVCA, 2007)

The government's nascent use of VC may make some stakeholders nervous because VC challenges traditional R&D practices. Yet, this falls in the same category as other successful government programs which are now privately managed—such as privatized military housing A-76 initiatives, aircraft maintenance performed by contractors for flying training units, and the Non-appropriated Fund Instrumentality (NAFI). There are precedents for using commercial best practices to improve government processes, and VC is simply a potential way to improve the government's R&D.

3. Funding Possibilities and Mechanisms to Support VC in QDR Investment Areas

The government's portfolio of VC initiatives has grown significantly since the inception of In-Q-Tel in 1999. This last section of our analysis proposes ways for the

DoD to use its existing VC initiatives and potentially expand them to support the *QDR* investment areas. Specifically, the following questions are answered for each *QDR* investment area: 1) are the existing Government VC initiatives postured to fill capability gaps in the *QDR* areas of investments, and, if not, 2) which model(s) are best suited for each investment area?

4. Information Technology

The information technology area of investment holds the most promise for Government VC initiatives' success. To many entrepreneurs, especially in Silicon Valley, VC and information technology funding are synonymous. Information technology projects—as opposed to other ventures which have a tangible end-product—have a certain "translucence" that VCs seem to able to see which traditional lending institutions cannot. The government should have few problems pooling its money with other investors for new VC opportunities. In-Q-Tel, DeVenCI, SBIR, NTA, and ACIN are currently postured to support information technology.

5. Intelligence and Surveillance

One of the primary reasons for creating In-Q-Tel was to rapidly and economically update the CIA's anachronistic technology so it would be commensurate with the capability levels in other parts of the government. Arguably the most successful Government VC initiative to date, it has been the impetus for dual-use technologies (such as Google Earth, an iteration of Keyhole, Inc.'s revolutionary mapping system) which not only have spilled over into the DoD, but into the homes of personal computer users. Considering the size of the government and pejorative references to its bureaucratic nature, we argue the intercommunication between the CIA and DoD intelligence agencies is less than ideal. Therefore, we recommend the government consider devising a way to funnel DoD intelligence interests to In-Q-Tel to factor in its investments. This consolidation may spur further idea-sharing and innovation. In-Q-Tel, DeVenCI, SBIR, NTA, and ACIN are currently postured to support intelligence and surveillance.

6. Medical and Biotechnology

There are many benefits of a separate VC entity dedicated to closing medical and biotechnology capability gaps, especially with the increase of dollars invested by VCs in this area since 2002. To be sure, the commercial world is essential if the DoD is to make progress in this area. One of the authors has witnessed several efforts to band with industry at Brooks City-Base, TX. At this installation, the Air Force Institute of Operational Health works side-by-side with biotech companies through CRADAs. The researchers not investigate whether CRADAs seem to produce more favorable results than Government VC initiatives for medical and biotechnology concerns, but this would be an excellent area for additional research.

Based on publicly available information, In-Q-Tel appears to lead the DoD with actual investments in this category (In-Q-Tel, 2007). There is no indication the other Government VC initiatives make significant investments in medical and biotechnology. Because of this gap, the government should consider using the Communication Catalyst Model to spur additional R&D.

7. Language and Cultural

The DoD's continued emphasis on learning languages and understanding cultures should manifest itself primarily in further development of products relevant to theater operations. We believe the Communication Catalyst models can be of greatest assistance here. For example, DeVenCI could interact with VCs, university officials, and industry leaders (i.e., well-known publishers like Berlitz, Pimsleur, et al) and urge them to develop beneficial products in less-researched areas. But are there not plenty of language materials available? If our next major theater of operations were Western Europe, the answer would be yes. Go to any large bookstore, and witness the barrage of books and CDs in Spanish, French, or German. Then as a comparison, see the amount of materials available for Dari, Pashto, Mandarin, Farsi, and Iraqi Arabic—little, if any. Other investment opportunities might involve biotechnology, so as to better understand cognitive processes associated with learning languages. These discoveries may lead to innovative products which will help DoD members assimilate difficult languages sooner.

8. Logistics

Because the researchers view military logistics and commercial logistics as vastly different, we believe the DoD would find it very difficult to band with VCs to develop dual-use technologies suitable for military without substantial modification. Wal-Mart's world-class "cross-docking" logistics system may be considered second to none, but at the same time, Target is not firing salvos at its warehouses or semis to gain market share. That is, the threats to the military logistics system are not the same as for commercial entities.

In searching through the Venture Economics Industry Codes (VEIC), the researchers found that logistics involved a mix of technologies already present in the foregoing categories, to include Internet developments, software packages, and electronic devices. That is, logistics appears to be an aggregate of technologies from other areas. Thus, military logistics seems most apt to benefit from developments in computer software and hardware sectors. To a lesser extent, the business/financial and industrial/energy sectors have valuable input for logistics, only for the reason that fewer relevant VEICs were found in the researchers' analysis as compared to the other sectors. The Communication Catalyst VC models, which we know have especially close ties to the information technology world, are best positioned to spread the word about logistical gaps. Equity investments are not recommended because the products likely to help the DoD would probably be of little interest to many commercial companies; the ensuing technologies would be diversified enough for commercial sales. This does not mean the DoD has nothing to learn from the commercial world. On the contrary: the most effective way to incorporate commercial best practices for logistics is already happening—through the increasing reliance on contractors to perform DoD functions.

VII. CONCLUSION

This research project's primary question asked whether Government VC should be executed in a centralized or decentralized manner. In order to determine the answer to this question, this paper had three research objectives: 1) to determine the differences, as well as the advantages and disadvantages, of the various Government VC initiatives, 2) to compare and contrast the investment portfolios of the Government VC initiatives, and 3) to determine if the VC industry provides a relevant source for government R&D.

This project characterized the distinction between the VC initiatives as a spectrum. The Government VC Spectrum characterizes the initiatives as an Equity Investment, Grant, or Communication Catalyst Model. The table below summarizes the specific advantages and disadvantages for each of these models.

ADVANTAGES	Social Network	Overcome Bureaucracy	Certification Effect	Leverage funding	Increased insight	Enhance technology base	Fill funding gap	Minimize cost
Equity Investment Model	X	X	X	X	X		X	X
Grant Model	X	X	X			X	X	
Communication Catalyst Model	X	X						X
DISADVANTAGES	Potential ethical conflicts	Change management challenges	Human resource intensive	Technology Transition challenges	Difficulty measuring success	Unintended Consequences: Crowding out effect	Unintended Consequences: Manipulation of the system	
Equity Investment Model	X	X	X	X	X			
Grant Model				X	X	X	X	
Communication Catalyst Model				X	X			

Figure 31. Summary of Advantages and Disadvantages of Government VC Models

Each of the current Government VC initiatives possesses distinguishing characteristics that classify it as an Equity Investment, Grant, or Communication Catalyst Model. This specialization enables the government to take advantage of the strengths of VC at various stages of financing. The Communication Catalyst Model enables the government to identify technologies in *all* stages at a relatively low cost. The Grant Model enables the government to fill the funding gap for startup companies and to bring

technologies to the market that might otherwise have never matured. The Equity Investment Model takes advantage of the early stages of financing by leveraging the government's relatively small amount of capital to gain insight and to influence to startup company decisions.

In comparing and contrasting the government VC initiatives to the VC industry, research showed that the government VC initiatives' total capital under management (budget) is significant enough compared to some of the private VC firms. The government VC initiatives align with current VC trends by investing in early stage (Series A and B) funds with the increase in startup and seed-stage companies. The exits (IPOs or M&A activity) for companies with equity investments by the government are comparable or exceed the averages in the VC industry. Even though government VC initiatives do not focus on ROI in contrast to the VC industry, there is evidence for potential ROI for equity investments. These returns can further support R&D efforts for the government. Decentralization enables the government to effectively manage its limited capital, while at the same time positioning it to exploit the recent increase in early-stage companies in the VC industry.

To determine if the VC industry provides a relevant source for government R&D, this project analyzed the QDR's recommended investment areas. VC is a relevant source for government R&D for three primary reasons. First, VC is a relevant due to the ever-increasing employment of dual-use technologies. Second, traditional government acquisition practices tend to be slower, do not leverage funds, and do not share processes with the commercial to the same degree as VC. Lastly, the *QDR* investment areas are highly reliant on Internet-based technologies, which coincide with VC trends.

Numerous arguments support centralizing Government VC decision-making. Centralized execution increases control, insight, awareness, and accountability. In addition, centralization provides a greater pool of capital. Unfortunately, all the arguments for centralization are favored by a risk-averse culture. In order to truly harness the innovation from VC, the government must take risks. Indeed, executing VC in a decentralized manner enables the government to leverage risk across the VC model spectrum.

Despite the benefits of the VC initiatives, the government must still contend with the challenge posed by technology transition. Perhaps this is a crossover from the same problem plaguing traditional government acquisition and R&D efforts. As the government concentrates on VC, it should plan to integrate VC initiatives and technology transition efforts. Failure to do so will nullify the premise of Government VC—to bring about a return on technology.

In summary, the government should continue to foster decentralized VC execution. The government needs to support efforts that effectively import innovative technologies and provide improved capabilities to the warfighter. The current Government VC initiatives achieve these goals through equity investments, grants, and communication forums. By recognizing the advantages and disadvantages of the initiatives, the government can make improved decisions about how to use VC in the future.

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APPENDIX A. VC PORTFOLIO COMPANIES

A. IN-Q-TEL PORTFOLIO COMPANIES

3VR Security: Provides Searchable Surveillance Systems™ and services. **www.3vr.com**

A4Vision: 3-D facial recognition for identification and access control. **www.a4vision.com**

AdaptivEnergy: leading innovator of advanced Ruggedized Laminated Piezo actuators. **www.adaptivenergy.com**

Agent Logic: Agent-based event detection and response software. **www.agentlogic.com**

ArcSight: Provides solutions that reduce risks and protects critical information assets – ArcSight protects your business. **www.arcsight.com**

Attensity: The leader in text analytics software for business intelligence. **www.attensity.com**

Basis Technology: Foreign language document and media exploitation. **www.basistech.com**

Bay Microsystems: Internetworking processor. **www.baymicrosystems.com**

BBN Technologies: Speech recognition application in multiple languages. **www.bbn.com**

CallMiner: The leading provider of conversation analytics designed to uncover actionable intelligence from recorded calls. **www.callminer.com**

Cambrios: Wet coating process materials for display manufacturing. **www.cambrios.com**

Cassatt: Improves performance reliability, and management of enterprise infrastructure. **www.cassatt.com**

Convera: Enterprise search and categorization platform for mission-critical applications. **www.convera.com**

COPAN Systems: Enhanced MAID for persistent data storage and management. **www.copansys.com**

Destineer: Developer and publisher of videogames and 3-D training simulations. **www.destineerstudios.com**

Dust Networks: Embedded wireless sensor networking for monitoring and control applications. **www.dustnetworks.com**

Electro Energy Inc.: High-power, high-voltage battery technologies. **www.electroenergyinc.com**

Ember: ZigBee-compliant wireless semiconductor systems that enable low-cost, low-power mesh networking applications in any industry. **www.ember.com**

Endeca: Next-generation information retrieval and analysis through advanced search and guided navigation. **www.endeca.com**

FortiusOne: Emerging Leader in Intelligent Web Mapping. **www.fortiusone.com**

Fluidigm: Integrated fluidic circuits for high-throughput bioassays. **www.fluidigm.com**

FMS: Database-driven COTS link analysis software specifically designed for visualizing complex and disparate threat information. **www.fmsasg.com**

IDELIX: Immersive user interface technology. **www.idelix.com**

iMove: Immersive imaging solutions for wide area and geospatial surveillance. **www.imoveinc.com**

Infinite Power Solutions (IPS): Flexible, rechargeable, solid-state thin-film batteries. **www.infinitepowersolutions.com**

Infobionics: The Cellular Database Management System™ that delivers an unprecedented combination of flexibility and performance data search and analysis. **www.infobionics.com**

Initiate Systems: Entity resolution and information sharing about persons, organizations, objects, and events. **www.initiatesystems.com**

Inxight: Extraction and retrieval tools for gathering, analyzing, and sharing information. **www.inxight.com**

Kofax : Information capture and classification for document exploitation. **www.kofax.com/products/mohomine**

Language Weaver: Statistical machine translation software for the automated translation of human languages. **www.languageweaver.com**

MetaCarta: Geospatial data fusion. **www.metacarta.com**

Microchip Biotechnologies, Inc., (MBI): The NanoBioProcessor™ systems. **www.microchipbiotech.com.**

MotionDSP: Specializes in video image processing. **www.motiondsp.com.**

Nanosys: Nanotechnology-enabled systems. **www.nanosysinc.com**

Network Chemistry: RF-based monitoring and analysis. **www.networkchemistry.com**

Nextreme Thermal Solutions: High efficiency capabilities for converting heat to electrical energy and for emplaced sensors and equipment. **www.nextremethermal.com**

NovoDynamics: Document exploitation and OCR for Middle Eastern languages. **www.novodynamics.com**
Paratek: Electronically tunable RF circuitry for multi-function, multi-frequency wireless devices. **www.paratek.com**

piXlogic: Image segmentation and search engine that analyzes, indexes, and searches the contents of image and video files. **www.pixlogic.com**

Qynergy: Long lasting power solutions. **www.qynergy.com**

Rhevision Technology: Revolutionary optics technology for miniature and mobile imaging. **www.rhevision.com**

Rosum: Location technology that combines terrestrial TV and satellite GPS signals for reliable indoor and outdoor location on mobile assets. **www.rosum.com**

Sionex: Protection by Detection™. **www.sionex.com**

SkyBuilt Power: Power Anywhere™ – the mobile, renewable energy power station. **www.skybuiltpower.com**

Spotfire: Enterprise analytics software offers radically faster business intelligence. **www.spotfire.com**

Stratify: Intelligence-at-a-glance™ from vast amounts of unstructured information. **www.stratify.com**

StreamBase Systems: High-performance Complex Event Processing software platform for real-time and historical analysis of high-volume intelligence data. **www.streambase.com**

Tacit: Automated expertise sharing and relationship networking for the on-demand enterprise. **www.tacit.com**

Tendril: Bridging the gap between sensor networks and solution programmers. **www.tendrilinc.com**

TenXsys: Remote monitoring of health and location for humans and animals. **www.tenxsys.com**

TerraGo Technologies: Provides solutions that help GIS professionals share interactive, georegistered maps with users anywhere in connected or disconnected modes. **www.terragotech.com**

Thetus: Knowledge modeling and discovery software. **www.thetus.com**

Traction: Beyond Blogs and Wikis, there's Traction. **www.tractionsoftware.com**

Visual Sciences: Real-time visual analysis platform for large datasets. **www.visualsciences.com**

WiSpry: Tunable RF silicon solutions. **www.wispry.com**

B. NTA-RTVG PORTFOLIO COMPANIES (PARTNERS)

Independent Needs Analysis and Outreach, Technology Assessment and Evaluation

- Ashland Institute
- BearingPoint
- Cipher Systems
- Gartner
- KENTIA Management Corporation
- Potomac Institute
- Sullivan-Haave
- Swiftsure Spatial Systems
- SYNTEK Technologies
- The SPECTRUM Group

Technology Research and Development and Prototyping

- Applied Minds
- Atinav
- BBN Technologies
- Carnegie Mellon University
- Center for Higher Learning
- George Mason University
- Georgia Tech Research Institute
- Midwest Research Institute
- Mississippi Enterprise for Technology
- Mississippi Space Commerce Initiative
- Motorola
- Penn State University Applied Research Laboratory
- Purdue University
- Rockwell Scientific Company
- Sarnoff Corporation
- Southwest Research Institute
- SRI International
- Thirteen/WNET New York
- University at Buffalo, State University of New York
- University of Florida
- University of Illinois Urbana—Champaign
- University of Southern Mississippi
- User Systems
- Virginia Polytechnic Institute & State University
- West Virginia University

Product Development and Commercialization

- Aquilent
- Brilliant Media
- Cambridge Display Technology
- Cree
- DigitalGlobe
- ESRI
- Fortrex Technologies
- HP Invent
- ImageLinks
- InPhase Technologies
- Iridian Technologies
- Leica Geosystems GIS and Mapping
- Magfusion
- Microlab
- ObjectFX
- Observera
- PacketVideo
- Saffron Technology
- Scyld Computing Technology
- Semandex Networks
- Terabit Corporation
- Teranex
- The Boeing Company
- Trimble
- U.S. Display Consortium
- Vexcel Corporation
- Virage
- Wavexpress

Technology Insertion and System Integration

- Applied Signal Technology
- Booz Allen Hamilton
- Computer Sciences Corporation
- EER Systems
- General Dynamics
- IBM Consulting
- Intergraph Corporation
- Lockheed Martin Corporation
- Northrop Grumman—TASC
- Open Source
- Radiance Technologies
- Raytheon
- SAIC
- SMI Defense Group
- Titan Systems Corporation
- Unisys Corporation

C. ACIN PORTFOLIO COMPANIES

Altech Services Inc.
Ambient Control Systems, Inc.
Applied Integrated Technology
Aries Computer Systems, Inc.
Channel Logistics
Custom Manufacturing & Engineering
Datatek Corp.
David H Pollock, Consultant
Drakontas, LLC
ENI Systems
eSource Group
Freedom Vertical Technologies
Gestalt, LLC
Hi-Tec Systems, Inc.
INT Group
Iridian Technologies
Layered Intelligence Corp.
Lightwave Telecommunications
MegaPhase, Inc.
MobileStrat, Inc.
MTC Technologies
Nova Training & Technology
Oak Environmental Consultants
Phacil, Inc.
Physical Acoustics
proServices Corp.
Prototype Productions Inc.
Quantum Energy Systems
R.L. Associates
Rapport, Inc.
Smarter Agent
Stellar Services
Synthosys
Technica, LLC
USFalcon
Vortechx Applied Technologies

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APPENDIX B. *QDR* REFERENCES

This appendix contains specific references to technologies and capabilities from the QDR that the government must consider before executing a VC initiative. These are direct quotes from the *QDR* (2006, February 6). Bolded areas are of particular importance; emphasis added by the researchers.

A. DoD OVERALL GOALS

- This war requires the U.S. military to adopt **unconventional and indirect approaches** (p. 1).

- The aim is **to possess sufficient capability** to convince any potential adversary that it cannot prevail in a conflict and that engaging in conflict entails substantial strategic risks beyond military defeat (p. 31).

- [The] Department's senior civilian and military leaders identified four priority areas for examination during the QDR: Defeating terrorist networks. Defending the homeland in depth. Shaping the choices of countries at strategic crossroads. Preventing hostile states and non-state actors from acquiring or using WMD (p. 33).

- During this QDR, senior leaders confirmed the importance of the main elements of that Force Planning Construct: maintaining the ability to defend the U.S. homeland; continuing to operate in and from forward areas; and above all, **the importance of maintaining capabilities and forces to wage multiple campaigns in an overlapping time frame—** for which there may be little or no warning of attack. This latter capability in particular remains a strong deterrent against opportunistic aggression or attempted coercion (p. 36).

- Two fundamental imperatives for the Department of Defense: Continuing to **reorient the Department's capabilities** and forces **to be more agile** in this time of war, to prepare for wider asymmetric challenges and **to hedge against uncertainty** over the next 20 years (p. 1).

B. INFORMATION TECHNOLOGY

- **Increase resources to develop software**, tactics, techniques, procedures and other initiatives needed to support the Global Force Management System (p. 60).

- **Increase investment to implement the Global Information Grid (GID), defend and protect information and networks** and focus research and development on its protection. **Develop an information-sharing strategy to** guide operations with Federal, state, local and coalition partners (p. 59).

- During the QDR, the senior leadership of the Department **considered potential adjustments to capabilities** and forces in light of the four focus areas and refined Force Planning Construct. They identified desired future force characteristics prior to developing proposals for the **following capability portfolios:** joint ground; special operations forces; joint air; joint maritime; tailored deterrence; combating WMD; joint mobility; ISR and space capabilities; **net-centricity**; and joint command and control (p. 41).

- [The Department must] make additional **investments in information assurance** capabilities to protect information and the Department's computer networks (p. 50).

- [The Department must] **automate and link key planning processes in a networked, virtual environment** to enable real-time collaboration and rapid production of high-quality planning products (p. 60).

- [The Department must find] **capabilities to locate, tag and track terrorists in** all domains, including **cyberspace** (p. 23).

- At the same time, **expanded reliance on sophisticated electronic technologies** by the United States, its allies and partners **increases their vulnerability to the destructive effects of electromagnetic pulse (EMP)—**the energy burst given off during a nuclear weapon explosion (p. 33).

- [The Department must acquire] **secure broadband communications** into denied or contested areas to support penetrating surveillance and strike systems (p. 55).

- [The Department must acquire] **joint command and control capabilities that are survivable in** the face of WMD-, **electronic, or cyber-attacks** (p. 32).

C. MEDICAL/BIOLOGICAL

- Transforming the Medical Health System (MHS). **New breakthroughs in science and health, and new innovations in prevention and wellness** offer the opportunity to develop a 21st-century Military Health System that will improve health and save both lives and money (p. 72).

- [The Department is] is helping to develop vaccines for Project BioShield, a national effort to **accelerate the development of medical countermeasures to defend against potential biological attacks**. In Project BioWatch, the Department collaborates with other Federal agencies on **improving technologies and procedures to detect and identify biological attacks**. In 2004, the Department led the establishment of the National BioDefense Campus at Fort Detrick, Maryland, which provides a means for coordination among agencies working on research and development of medical biological defenses (p. 15).

- [The Department must acquire] **broad spectrum medical countermeasures to defend against genetically engineered or naturally mutating pathogens** for which there are no current defenses (p. 39).

- To strengthen homeland defense and homeland security, the Department will **fund a $1.5 billion initiative over the next five years to develop broad-spectrum medical countermeasures** against the threat of genetically engineered bio-terror agents. Additional initiatives will include **developing advanced detection and deterrent technologies** and facilitating full-scale civil-military exercises (p. 17).

- For the next five years, beginning in Fiscal Year 2006, the Department is further **increasing funding for the Chemical Biological Defense Program (CBDP) by an additional $2.1 billion (an increase of approximately 20%),** focused primarily on improving its research, development and testing infrastructure as well as expanding efforts to improve defenses against emerging chemical and biological threats (p. 63).

- Progress to Date: Since the 2001 QDR, the Department has nearly **doubled its investments in chemical and biological defenses** and implemented several important organizational changes to address the challenges posed by WMD more effectively (p. 63).

D. INTELLIGENCE & SURVEILLANCE

- The ability of the future force to **establish an "unblinking eye" over the battle-space** through persistent surveillance will be key to conducting effective joint operations. Future capabilities in ISR, including those operating in space, will support operations against any target, day or night, in any weather, and in denied or contested areas. The aim is to integrate global awareness with local precision. Intelligence functions will be fully integrated with operations down to the tactical level, with far greater ability to reach back to intelligence collection systems and analytic capabilities outside the theater (p. 55).

- **Capabilities and organizations to help fuse intelligence and operations to speed action based on time-sensitive intelligence** (p. 35).

- **Investments in moving target indicator and synthetic aperture radar capabilities**, including Space Radar, will grow to provide a highly persistent capability to identify and track moving ground targets in denied areas (p. 69).

- **One of the greatest challenges facing U.S. forces is finding the enemy and then rapidly acting on that information.** To address this challenge in Iraq, the Department has established in the theater the Joint Intelligence Operations Center—Iraq. This Center integrates intelligence from all sources—imagery, signals intelligence, and human intelligence—and then fuses that information with planning and execution functions to support operations that are often conducted within hours or even minutes of receiving an intelligence (p. 11).

- [The Department has a] **need for considerably better fusion of intelligence and operations** to produce action plans that can be executed in real time. [We have come to the] realization that everything done in this Department must contribute to joint warfighting capability (p. 23).

- [The Department must improve] **air and maritime domain awareness capabilities to provide increased situational awareness and shared information** on potential threats through rapid collection, fusion and analysis (p. 27).
-
- [The Department must] **improve responsive space access, satellite operations, and other space-enabling capabilities. Capability portfolios** would include network-based command and control, communications on the move and information fusion. Current and evolving threats highlight the need to design, operate and defend the network to ensure continuity of joint operations (p. 70).

- [The Department shall be] **invested in new equipment, technology and platforms for the forces, including advanced combat capabilities**: Stryker Brigades, Littoral Combat Ships, converted cruise-missile firing submarines, unmanned vehicles and advanced tactical aircraft—**all linked by Net-centric Warfare systems** (p. viii).

E. LANGUAGE AND CULTURAL SKILLS

- Recent operations have reinforced the need for U.S. forces to **have greater language skills and cultural awareness**. It is advantageous for U.S. forces to speak the languages of the regions (p. 14).

- [The] Department will **increase investments focused on developing and maintaining appropriate language, cultural, and information technology skills** (p. 5).

F. NEED TO MINIMIZE COSTS AND INNOVATE

- Lessons from these missions, which informed the *QDR*'s deliberations and conclusions, include the critical importance of minimizing costs to the United States while imposing costs on adversaries, in particular by **sustaining America's scientific and technological advantage** over potential competitors (p. 3).

- "The principles of transparency, constructive competition to **encourage innovation,** agility and adaptability, collaboration and partnership should guide the formulation of new strategic processes and organizational structures" (p. 1).

- Capital Acquisition and Macro Resource Allocation—Shape the Department's **major investments** in people, **equipment, concepts** and organizations to support the Nation's objectives most effectively (p. 66).

- [The Department] must also provide the best possible value to the American taxpayer. Second, the Department must **provide information and analysis necessary to make timely and well-reasoned decisions**. Third, the Department must undertake reforms to **reduce redundancies and ensure the efficient flow of business processes** (p. 65).

- In confronting the range of security challenges it will face in the 21stcentury, the United States must constantly **strive to minimize its own costs in terms of lives and treasure, while imposing unsustainable costs on its adversaries**. Sustaining America's scientific and technological advantages over any potential competitor contributes to the nation's ability to dissuade future forms of military competition (p. 18).

- **Today, the armed forces are hampered by inefficient business practices** (p. 63).

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